

The Blast Furnace *and* Steel Plant

Vol. XI

PITTSBURGH, PA., NOVEMBER, 1923

No. 11

Education and Industry

PROPER selection and training of new men for positions of administrative and technical responsibility in industry are vital to the economic development of our country. The growing complexity of industry, as of all society, adds continually to the burden of those who occupy leading positions; hence they must be selected with increasing care and given a steadily broader and more thorough training.

A primary object of the engineering school is to develop young men for effective service in industry. It therefore follows that in the close co-operation between the engineering school and industry lies the means for the accomplishment of the aims of both.

Realizing the importance of this, the National Industrial Conference Board has joined with the Society for the Promotion of Engineering Education in appointing an Advisory Joint Conference Committee of industrialists and of educators and administrators in engineering schools to help guide the study of the problem. This committee, composed of men of broad business experience and scientific attainment, is as follows:

S. P. Bush, President, Buckeye Steel Castings Company, Columbus, Ohio.

H. E. Coffin, Vice President, Hudson Motor Car Company, Detroit, Mich.

Col. T. C. Dickson, U. S. A., Commanding Officer, U. S. Arsenal, Watertown, Mass.

Howard Elliott, Chairman, Northern Pacific Railroad, New York City.

E. M. Herr, President, Westinghouse Elec. & Mfg. Company, Pittsburgh, Pa.

William H. Nichols, Chairman, Allied Chemical & Dye Corporation, New York City.

A. H. Rogers, Rogers, Mayer & Ball, Consulting Mining Engineers, New York City.

Henry D. Sharpe, Treasurer, Brown & Sharpe Mfg. Company, Providence, R. I.

and

R. H. Fernald, Director of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa.

H. J. Hughes, Dean, Harvard Engineering School, Cambridge, Mass.

Dugald C. Jackson, Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

F. W. McNair, President, Michigan College of Mines, Houghton, Mich.

J. W. Roe, Professor of Industrial Engineering, New York University, New York City.

Herman Schneider, Dean, College of Engineering and Commerce, University of Cincinnati, Cincinnati, Ohio.

Charles F. Scott, Professor of Electrical Engineering, Yale University, New Haven, Conn., and President, Society for the Promotion of Engineering Education.

Frederick P. Fish, Chairman of the National Industrial Conference Board, acting as Chairman of the Advisory Joint Committee, and Magnus W. Alexander, Managing Director of the National Industrial Conference Board, has organized the work of the committee. Oliver S. Lyford, who was one of the representatives of the Conference Board on its European Commission in 1919, has been in immediate charge of the preparation of this report.

The Ruhr Losses*

Germany's Viewpoint in Terms of Future Competition

By HUBERT HERMANN†

GERMAN iron and steel manufacturers have at all times followed with sincere admiration the unexampled development of the American iron and steel industry. Numerous Germans remember with the greatest satisfaction their frequent visits to American works, where they were given an opportunity to study this development and in particular the endeavors aiming at the saving of labor and increase of production on the spot. They remember in particular the friendly reception extended to them by the American works and the readiness with which they received the fullest information about every detail.

Institute about studies made shortly before at American works by a German expert. Although the working conditions in the German iron works differed and still differ in many regards from those prevailing in America, the German iron and steel industry has frequently been stimulated by the work carried out in American mills and utilized the American progress attained. This will probably also be the case in the future, perhaps even to a greater extent.

In recent personal interviews with American iron and steel manufacturers, the writer had frequent opportunities to hear, that the American interest in the development of the German iron industry after the war is very great indeed. The writer is therefore under the impression, that a report about it may prove of interest, the more so as owing to the invasion of the Ruhr by French and Belgian troupes an emergency has arisen, the result of which cannot be forecast at the present time. This report will not touch on the political aspect of the matter and is intended to show only the real position at the present time by figures and illustrations.

It is impossible to gain a clear picture of the present position of the German iron and steel industry, if its present extent is not compared with the extent before the war and if, above all, the losses of territory, which Germany has suffered by the peace treaty of Versailles are not considered. Germany's total area at the present time is 183,000 square miles, 13,345 square miles of which are occupied. These figures give, however, only an incomplete picture. As the occupied territories have triple the denseness of population as the remaining parts of Germany, the number of Germans whose territory is occupied by the foreign military is proportionally far greater than the area indicates. At the present time Germany has 63 millions of inhabitants. Of these 7 millions reside in the previously occupied territory on the Rhine and 5 millions in the lately occupied Ruhr district, which amounts to a total of 12 millions or about one-fifth of the entire population. To appreciate fully the importance of this figure, it is necessary to compare it with the number of inhabitants of other states. The total population of Canada for instance, amounts to about nine millions and that of the Argentine to about eight millions, so that the number of Germans suffering under the foreign military is 50 per cent greater than the entire population of Argentine.

Fig. 1 shows the total occupied territory on the Rhine and the Ruhr, while Fig. 2 shows the occupied Ruhr district only. The importance of the Ruhr district will be appreciated from the following figures: In Germany on the average 330 people live on one square mile, in the Ruhr district on the other hand 4,038, that means more than 10 times as many. While in the whole of Germany of 100 workers 38.3 work in mining and the iron industry, this figure rises in the Ruhr district to 65.9. Of 754,000 Germans, who are in the whole of Germany occupied in mining and the iron industry, 328,000 or 43.5 per cent reside in the

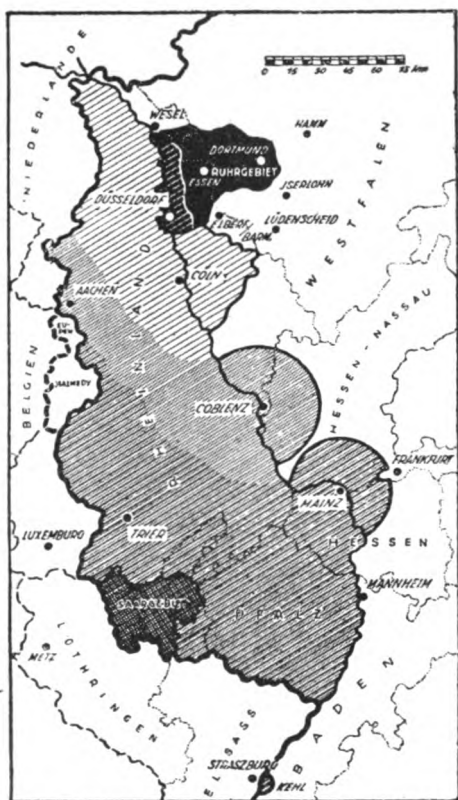


FIG. 1—The total occupied territory.

We Germans today see with the same admiration how this development of the American iron and steel production proceeds and has at the present time even broken the records set up during the war. Nothing is of greater interest to the German iron and steel manufacturer than the reports in the German technical periodicals, in particular in the journal "Stahl und Eisen" well known in America, about the progress which has lately been made in American works in technical and economical directions. The writer remembers well a paper read in the fall of last year at the general meeting of the German Iron and Steel

*This is the fourth of a series of analyses of the European entanglement. We have viewed the situation through French, British and Italian eyes. This viewpoint of the Germans is interesting.

†Consulting Engineer, Berlin, Germany.

Ruhr district. Of the total coal reserves, which remain to Germany after the loss of seven-eighths of the important Upper-Silesian coal mines and which are estimated to amount to 264 milliards of tons, 213.6 milliard tons or 80.9 per cent of the entire German coal reserves fall to the Ruhr district. In 1922 the total German coal production amounted to about 130 million tons, of which 92 million tons or 71.1 per cent were produced in the Ruhr.

It is well known that the Ruhr district produces an excellent coke coal. The Ruhr coke is, owing to its hardness, the best German blast furnace coke and dominates over the entire German blast furnace works. Approximately one-third of the Ruhr coal produced is converted into coke on the spot. Of this approximately 18.5 million tons were, in 1922, supplied to countries of the Entente, primarily France and Belgium, in accordance with the peace treaty of Versailles. About one-third of the total production of coke coal was thus claimed by the Entente. These figures are the more important, as Germany, which was, before the war, a coal exporting country, was obliged, in 1922, to import about 7.5 million tons of coal from abroad, mainly from England, to keep her own industries going.

The separation of the Lorrain iron ore district, which used to be the mainstay of the German blast furnaces, has also entirely dislocated the ore supply of the German blast furnace works. Germany pro-

duces half of all ore deposits and one-third of the blast-furnaces as well as one-third of the coal of the Continent of Europe, controls at the present time three-fifths of the pig iron production and seven-tenths of the entire coal of the Continent.

The known and mined iron ore deposits of Europe

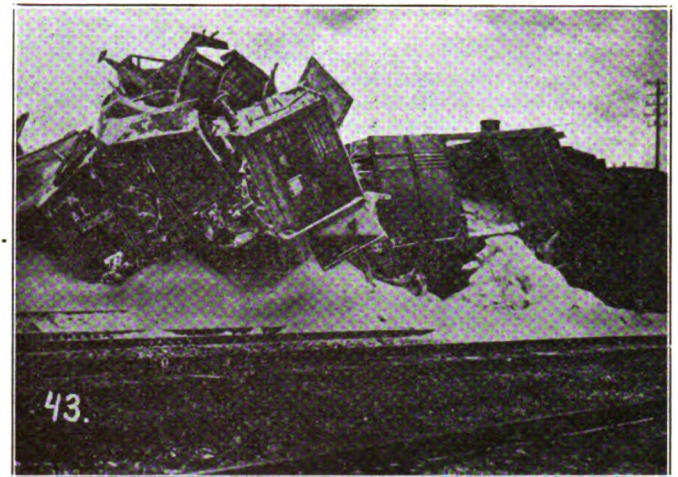


FIG. 3—Evidences of destruction wrought in the Ruhr.

are estimated at 10 milliard tons. In these ore reserves the various European states participate as follows:

	Mill. Tons	Per Cent
France	5,319	or 53.14
Great Britain	1,015	" 10.14
Sweden	749	" 7.48
Germany	726	" 7.25
Spain	679	" 6.78
Russia	630	" 6.29
Norway	238	" 2.38
Austria	217	" 2.17
Luxemburg	200	" 2.00
Checho-Slovakia	85	" .85
Poland	35	" .35

In the ore production the various states participated in 1920 in the following proportion:

	Million Tons
France	13.9
Great Britain	12.9
Germany	6.3
Spain	4.8
Sweden	4.5
Luxembourg	3.7
Poland	.2
Belgium	.002

The German iron works, and the Ruhr works in particular, obtained before the war a large portion of their ore requirements from Lorrain and France. In Germany of the present area were consumed in 1913 altogether 24.2 million tons iron ore (exclusive of manganese ore), and of these 12 million tons in the Ruhr district and four million tons in the Saar district. The German iron ore production amounts for the present area to 7.3 million tons. Thus 16.9 million of tons had to be made good by ores of foreign origin, which primarily came from the formerly German Lorrain. The iron ore production in Lorrain amounted in 1913 to approximately 21 million tons, of which about 13 million tons were consumed at the spot, so that approximately 8 million tons could be disposed of. France also consumed at the time of its iron ore

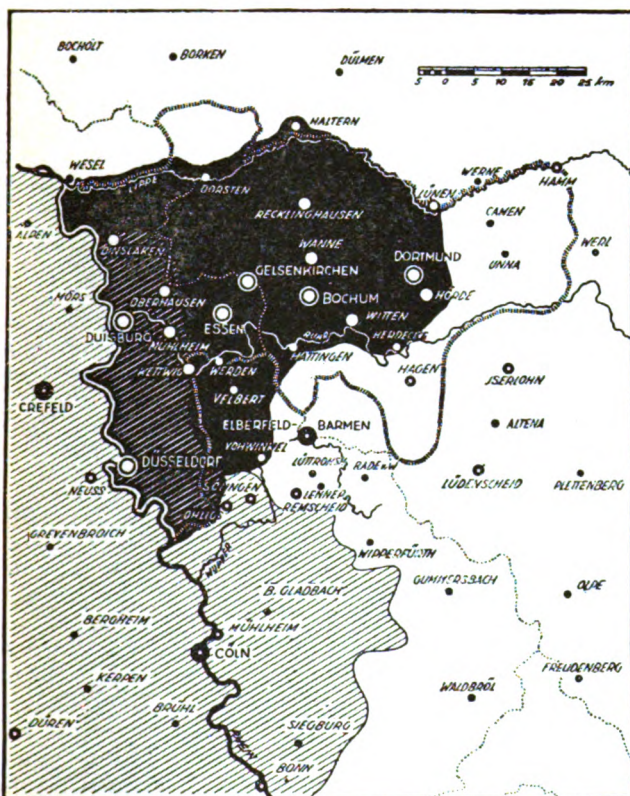


FIG. 2—The occupied portion of the Ruhr.

duced prior to the war in the year 1913 on her territory 16.8 million tons pig iron and 17.1 million tons of steel ingots. In 1920 the pig iron production dropped to 6,647,000 tons or 35.7 per cent and the ingot production to 8,136,000 tons or 42.2 per cent. By the military invasion of the Ruhr, France, which al-

production of 21.5 million tons only 13.3 million tons and supplied from the excess of 8.2 million tons very considerable quantities of iron ore to Germany, in exchange for coal from the Ruhr district.

Of the total consumption of iron ore in the Ruhr district of approximately 12 million tons the following amounts were derived from the following countries:

	Tons
German-Lorrain and Luxembourg...	3,561,000
Other German ore districts.....	603,000
Sweden and Norway.....	2,898,000
Spain and Portugal.....	1,255,000
Africa	635,000
Russia	335,000

In the year 1920 the consumption of iron ore in the German blast furnace works amounted to 10.7 millions tons. These were obtained from:

	Tons
Home ore mines.....	5,226,000
French ore districts.....	2,293,000
Sweden and Norway.....	1,736,000
Spain	394,000

Of the total consumption of iron ores 8.6 million tons or approximately 60 per cent were consumed in the Ruhr district, almost one-third of these consisting of home ores and two-thirds of foreign ores.

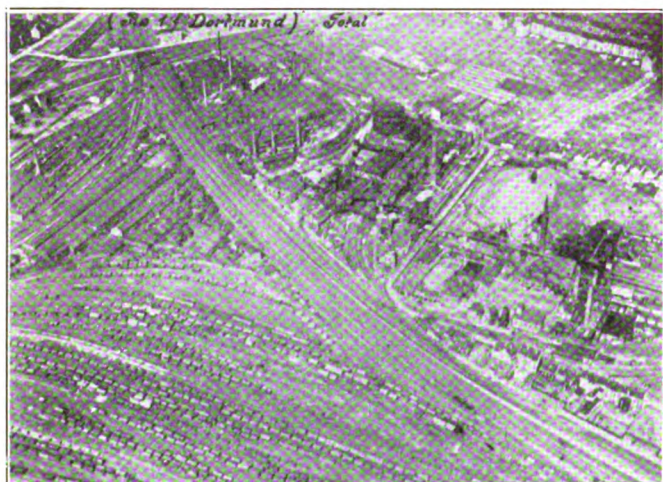


FIG. 4.—Aeroplane view of Dortmund Iron & Steel Works.

For the year 1922 a very considerable increase of the import of iron ores is to be recorded. The total import amounted to 11,014 million tons. Of these 2,069 million tons were of French origin, while Sweden and Norway supplied 5,508 million tons and Spain 1,339 million tons. This shows a decrease in the supplies from France, while the portions of the two other countries have considerably increased. This development may be explained by the fact that the French ores, which are poor in iron, can only be transported into the Ruhr district and the other German blast furnaces by rail, so that the price of the ores is considerably increased in comparison with the Scandinavian and Spanish ores, which can be conveyed by ship and are furthermore far richer in iron. The Swedish ore, for instance, has a content of iron of 40-70 per cent, while the French ores contain on the average only 30 per cent Fe.

As regards the pig iron production in Europe, this amounted in the year 1913 to 46.3 million tons. This was shared by:

Germany, in her former extent, 16.8 million tons, or 36.91 per cent.

France, in her former extent, 5.2 million tons, or 11.24 per cent.

Great Britain, 10.4 million tons, or 22.51 per cent.

According to the present political frontiers the European pig iron production is distributed over the principal iron in 1920 as follows:

Germany, in her present extent, 6.6 million tons.

France, in her present extent, 3.4 million tons.

Great Britain, 8.1 million tons.

The part of the Ruhr district in the German blast furnace and steel works in the year 1920 can be taken from the following figures, the figures in brackets holding good for the Ruhr district:

At 63 (31) blast furnace works with a total of 228 (125) blast furnaces 146 (100) furnaces were in blast. The number of steel works amounted to 103 (61) with a total of 665 (463) converters, open hearth furnaces, electric steel and crucible furnaces. From the preceding figures it will be obvious that the Ruhr district has a very considerable share in the total production of pig iron and steel.

Institute Meeting Held in New York

The twenty-fourth general meeting of the American Iron and Steel Institute was held at the Hotel Commodore, New York City, on Thursday, October 25, 1923.

Following the banquet which was held in the evening at the Hotel Commodore, a special train was run to Aberdeen, Md., and on Friday, October 26, the Institute held a joint meeting with the Army Ordnance Association at the United States Army Proving Grounds at Aberdeen.

The program included the firing of heavy railway mortars and guns, dropping of bombs from bombing aeroplanes, firing of anti-aircraft guns against moving targets in the air, demonstration of machine gun firing from aeroplanes, and machine gun barages on land, the attack of tanks against machine gun nests, etc. Large number of the members of the Institute avail themselves of this opportunity to witness these very interesting demonstrations.

Program of Papers.

Address of the president, Elbert H. Gary, chairman, United States Steel Corporation, New York.

X-ray Examination of Metals, Colonel T. C. Dickson, commanding officer, Watertown Arsenal, Watertown, Mass.

Investigation of the Influence of Temperature on Charpy Impact Value of a Group of Steels of Varying Composition—Dr. F. C. Langenberg, metallurgist, Watertown Arsenal, Watertown, Mass.

Open-hearth Furnace Regenerators—F. B. Quigley, superintendent, Open-hearth Department, Ohio Works, Carnegie Steel Company, Youngstown, Ohio.

Iron and Steel Industry in China—Chung Yu Wang, Hankow, China.

The Use of Blast Furnace Slag for Various Construction Purposes—C. L. McKenzie, president, Duquesne Slag Products Company, Pittsburgh, Pa.

Recent Developments in Steel Forging—John L. Cox, assistant to president, Midvale Company, Philadelphia, Pa.

Refractories in the Steel Industry

No Single Element Is More Important Than Refractories.
A Summation of Important Data.

By J. SPOTTS McDOWELL*

PART II

WELL-BURNED silica brick made from the Medina quartzite of Pennsylvania have a specific gravity of 2.38 or less;* those made from the Barboo quartzite of Wisconsin, 2.40 or less. The specific gravity of quartz is 2.65, cristobalite 2.33 and tridymite 2.28. Therefore a low specific gravity of silica brick indicates that the material is largely transformed to the low specific gravity forms of silica, and has acquired most of its permanent expansion.

The specific gravity of aluminous fireclay brick is 2.65-2.75; that of silicious clay brick somewhat lower.

Strength of Refractories.

The strength, toughness and resistance to abrasion

*Research Engineer, Harbison-Walker Company, Pittsburgh, Pa.

*D. W. Ross, Silica Refractories, U. S. Bureau of Standards, Technical Paper 116 (1919).

of refractory materials vary widely. These properties are important when the brick are required to resist abrasion or sustain loads while hot. In most cases, however, as in furnace walls and arches, only one end of the brick is heated, and the cooler end of the brick is many times as strong as necessary to sustain the load.

Clay brick, as a rule, have considerable resistance to pressure under heat up to the point where softening begins. The cold crushing strength varies greatly, depending upon character of clay, process of manufacture, and burn. For first quality brick it will vary from 500 to 3000 pounds per square inch on end, and for plastic clay brick it may amount to as much as 5000 pounds per square inch. When crushed at 1350 deg. C., first quality brick will begin to deform under a load of about one third their cold strength. The

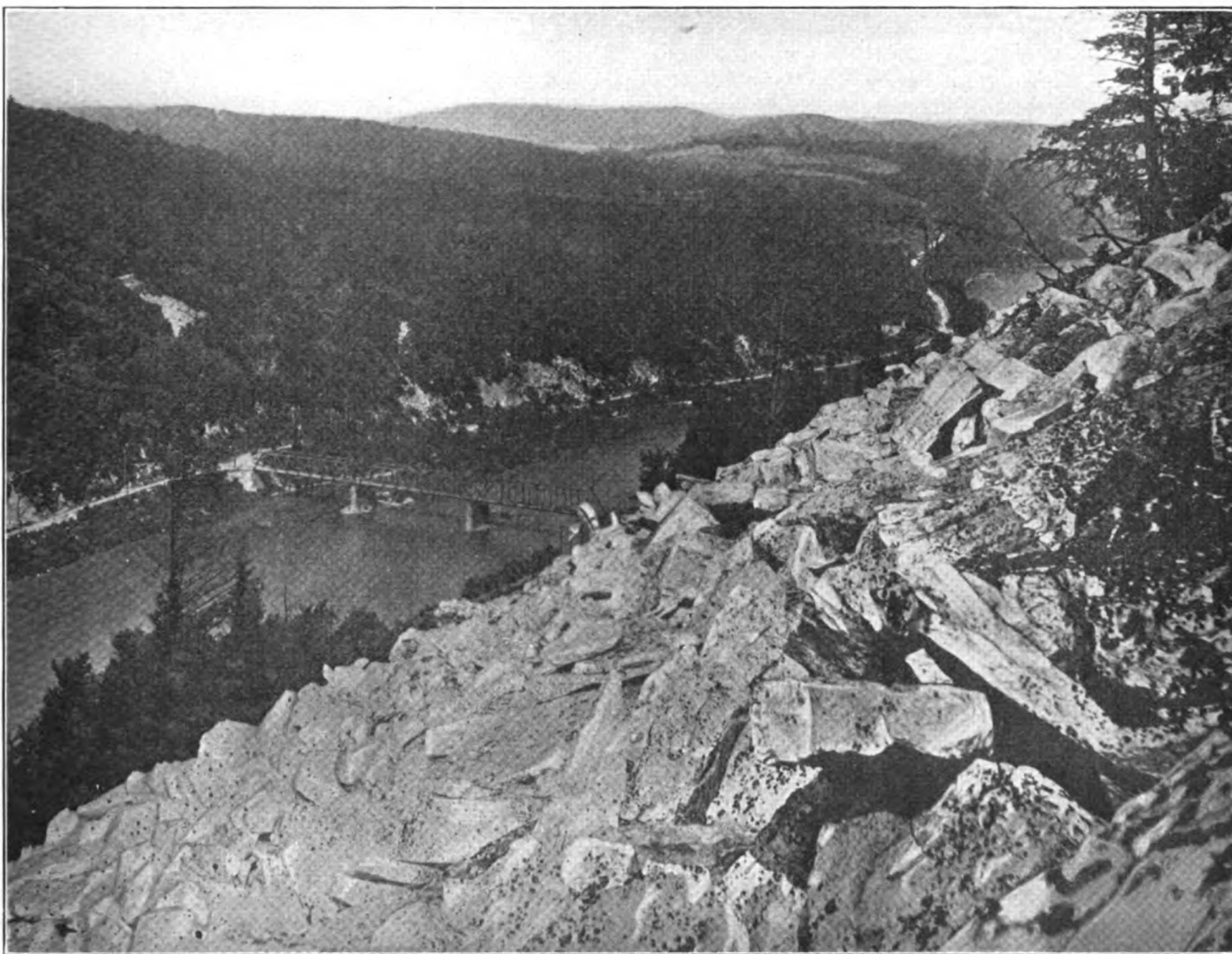


FIG. 5—Ganister floc in Jack's Narrows, Huntingdon County, Pa., showing steepness of slope. The river in foreground is the Juniata.

strength on edge and on flat is much more than on end.

Magnesia and chrome brick when cold, are very strong, having average cold crushing strengths of about 6000 and 4000 pounds per square inch. However, under heat they act as if the bond suddenly becomes weak at a certain temperature. Under a load of 50 pounds per square inch on end magnesia brick fail by shearing at 1450 to 1550 deg. C.; chrome brick from 1400 to 1450 deg. C.

Silica brick remain strong and rigid almost to their melting point. The end-crushing strength, cold, is 1000 to 2000 pounds per square inch; at 1450 deg. C., about 300 pounds per square inch.† The modulus of rupture, cold, is 400 to 900 pounds per square inch; at 1350 deg. C. about 1/3 of these values.‡

Hot Load Test.

Clay and high-alumina refractories have a wide range of viscosity and will deform at temperatures much below the melting point, under a comparatively light load. The deformation is a function of both time and temperature as well as of load; a given load may cause rapid distortion at a higher temperature and slow distortion at a temperature somewhat lower.

In the standard load test of the A. S. T. M.‡ the brick are subjected to a load of 25 pounds per square inch in a special furnace, heated in 4½ hours to 1350 deg. C. and held at that temperature for 1½ hours. After cooling, the brick are measured, and the shrinkage reported in percentage of the original length. The amount of deformation of firebrick is influenced by various factors; hard burned brick deform less than those of light burn; silicious clay brick less than flint-bond clay or high alumina brick; dense brick usually less than those of open and porous texture. With flint-bond clay brick of the same burn, the more refractory brick will usually deform less than those of lower refractoriness.

†E. N. McGee, Comparison of Hot and Cold Modulus of Rupture of Silica Brick, Jour. Am. Cer. Soc. 5 888 (1922).

‡Serial Designation C 16-20.

"The load test should be reserved for refractories which are actually to be used in places where pressure is an important factor."§ One reason for this is that an improvement in the hot load carrying capacity of the brick may often be brought about at the expense of certain other properties which may be desirable.

Thermal Conductivity.

The following figures on the thermal conductivity of refractories, as determined by Boyd Dudley¶ are expressed in calories per second, per square centimeter, for 1 centimeter thickness, for a temperature difference of 1 deg. C. The figures may be converted into Btu. per 24 hours, per square foot, per inch thickness, for 1 deg. F. temperature difference, by multiplying by 69,700.

CONDUCTIVITY

	Temperature		Mean K between
	t_1	t_2	t_1 and t_2
Silica brick	0	100	.0021
	0	1000	.0031
First quality clay brick, 52.9% SiO ₂ , 42.7% Al ₂ O ₃	0	100	.0016
	0	1000	.0025

Magnesia brick were found to have a constant conductivity of approximately .0135 between 445 deg. and 830 deg. C. The conductivity of chrome brick was not determined, but is probably somewhat lower than that of magnesia.

The mean conductivities for any two temperatures t_1 and t_2 up to 1000 deg. C., can be calculated from the formulae:

$$\text{For silica brick, } K = 0.0020 + 0.0011 (t_1 + t_2)$$

$$\text{For high grade clay brick, } K = 0.0015 + 0.0011 (t_1 + t_2)$$

§A. V. Bleminger in chapter on "Refractories," page 485, Vol. 1, Liddell's Handbook of Chemical Engineering, McGraw-Hill, 1922.

¶Boyd Dudley, Trans. Am. Electro Chem. Sec., 21, 336 (1915).

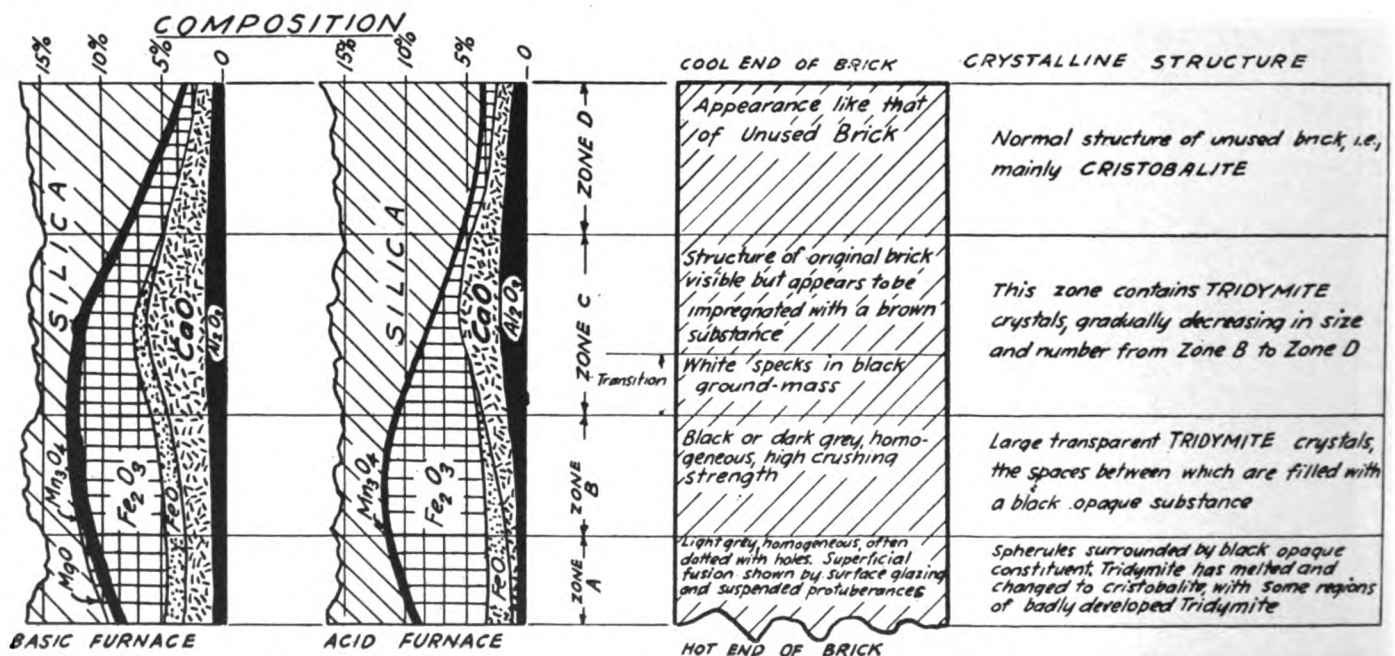


FIG. 6—Illustrates the stages of deterioration which open-hearth bricks pass through.



FIG. 7—A quarry of the Northwest Magnesite Company, Chewelah, Washington..

Horning* found the conductivity of a porous firebrick to be about 70 per cent that of a vitrified brick of low porosity.

The amount of heat flowing through a wall can be computed only approximately, for the computations must be based upon factors which are not known with exactness; moreover, the conductivity of the refractory is only one of the several factors working in series which affect the rate of heat transmission. The temperatures of the outer and inner wall surfaces are usually not definitely known. The effect of joints and surface resistance are uncertain. A luminous flame may cause greater heat transmission than one which is transparent. The conductivity of the refractories is altered by the absorption of material from the gases, or by the glazing or vitrification of the hot surface. Under forced draft much more heat will pass through the walls than under negative gas pressure.†

The use of insulating brick to prevent excessive loss of heat through furnace walls and arches is be-

*Roy A. Horning, Methods of Making Thermal Conductivity Tests, and the Transmission of Heat through Brick, Trans. Am. Cer. Soc. 18, 192 (1916).

†W. A. Hull, Thermal Conductivity of Refractories, Chem. Met. Eng., 27, 538 (1922).

‡Howe and Phelps, Heat Transmission, with Special Reference to the Stoker Fired Boiler, Jour. Am. Cer. Soc., 5, 420 (1922).

coming more common, and under certain conditions is good practice. The thermal conductivity of these brick is about 1/6 that of high grade firebrick at 200 deg. F., and 1/9 at 1600 deg. F.

Insulating brick are not extremely refractory and cannot be used at very high temperatures on account of shrinkage. Moreover, insulating raises the temperature of the refractory wall, in extreme cases to such a point that the hot end of the firebrick may reach the point of failure.

Specific Heat t°	Mean specific heat between 20°C and t°C (Heyn)	
	Silica	Magnesia
100°C	.209	.220
200	.219	.233
400	.237	.250
600	.250	.260
800	.261	.269
1000	.262	.278
1100	...	.282
1200	.266	.287
1300	...	.291

For clay brick, specific heat = $0.193 + 0.46 t$, where t is expressed in degrees Centigrate.§

Resistance to Temperature Changes.

Rapid temperature changes will cause most re-

§Wilson, Holdcroft and Mellor, Specific Heats of Firebrick at High Temperatures, Trans. Ceramic Soc. (Eng.) 12, 279 (1912-1913).

factories to crack or spall more or less. The spalling tendency is usually lowest in brick of the lowest thermal expansion, although it is affected by such properties as density, porosity, character of bond, and by the temperature. A brick which has a very low spalling tendency as it comes from the kiln, may in the furnace become dense at the surface due to vitrification or slag absorption, and this surface layer may be extremely sensitive to temperature changes.

In the tentative method of the A. S. T. M.[¶] for determining spalling tendency of clay brick, they are reheated five hours at 1400 deg. C. before the test.

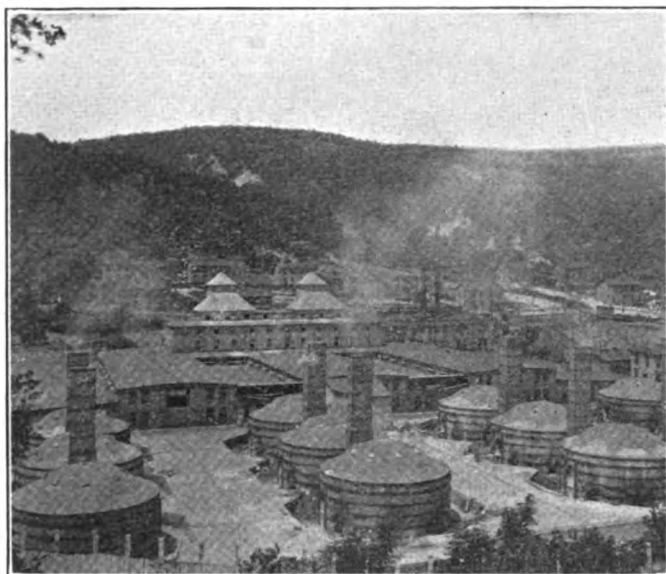


FIG. 8—Silica brick plant of Harbison-Walker Company at Mt. Union, Pa.

This consists in heating them at one end in a furnace wall to 1350 deg. for one hour, dipping them in water three minutes, allowing them to steam five minutes, and returning to the furnace. The total number of dips and percentage loss by weight are reported.

Flint-bond clay brick resist temperature changes very well; with increasing amounts of plastic clay the spalling tendency usually increases. As a rule light-burned brick are more resistant than hard-burned, coarse ground than finely ground, and hand made than machine made. Silica brick should be heated and cooled slowly and carefully below a dull red heat, being particularly sensitive at 230-270 deg. C. (450-520 deg. F.). However, above a red heat, silica brick will withstand rapid changes in temperature without injury. Magnesia and chrome brick do not withstand rapid temperature changes very well.

Selection of Refractories.

Economy in the use of refractories is largely governed by selection of the class of refractories best suited for the purpose intended. A careful study of the properties of the brick and of the working conditions will greatly aid in this selection.

Fireclay or silica brick should be used wherever they give satisfactory results, as they are inexpensive, easy to work with and require comparatively little care in handling. As clay brick are made of different clays and by different processes, the consumer

[¶]Serial Designation C—21 T.

is enabled to select brick with the particular combination of properties which most nearly meet his requirements.

The properties of silica brick are high refractoriness; high thermal expansion; strength and resistance to abrasion while hot; and sensitiveness to rapid temperature changes below a dull red heat. On account of their lightness and rigidity, they are especially valuable for use in arches; their high thermal conductivity adapts them to such service as by-product coke ovens, where heat must be transferred through the refractory.

Magnesia brick have high melting point, high thermal conductivity, and high resistance to basic slags. The chief value of chrome brick lie in their chemically neutral character and their high refractoriness. High alumina brick have high refractoriness and good slag-resisting qualities.

The use of difficult and intricate shapes is not to be recommended where avoidable. Standard sizes are usually preferable, and can be secured from the manufacture promptly when needed. Special shapes cost more, and require several weeks to manufacture.

Brick should be stored in a dry place, as exposure to weather weakens them. They should be laid with a mortar of high refractoriness.

Wherever possible they should be heated from one side only if the temperature is very high ample opportunity for radiation of heat will add greatly to the life of the brick. In laying silica brick, expansion joints of $\frac{1}{8}$ to $\frac{3}{16}$ -in. per foot should generally be provided; with magnesia and chrome brick, $\frac{3}{16}$ -in. to $\frac{1}{4}$ -in. per foot.

Use of Refractories in Iron and Steel Industry — Firebrick.

Blast furnaces and stoves, open hearth checkers, soaking pits, heating furnaces, boiler furnaces, stokers, cupolas, annealing furnaces, malleable and air furnaces, runners, sleeves, nozzles, ladles, furnace stacks and flues.

Silica Brick.

Open hearth furnaces, electric furnaces, crucible furnaces, by-product coke ovens, roofs of heating furnaces, roofs of pipe-welding furnaces.

Magnesia and Chrome Brick.

Basic open hearth furnaces, electric furnaces, lower courses of soaking pits and heating furnaces.

Blast Furnace.

Several kinds of brick are made for blast furnace linings, in order that the brick of each zone may be best adapted to the conditions existing there. Both hand-made and machine-made linings are used; at the present time there is a leaning toward hand-made brick for the hearth and bosh and steam-pressed for the inwall and top.

The hearth and bosh brick are of maximum refractoriness, and made of flint clay with sufficient bond to impart the necessary strength. They must resist the action at a high temperature of the molten metal and slag; the bottom blocks should be closely laid in order to prevent seepage of metal.

The inwall brick must withstand abrasion and chemical action at a fairly high temperature; and the disintegrating influence of furnace gases, which

seems to be intensified by certain metallic vapors, especially zinc.* Alkalies from lower in the furnace may deposit at the inwall, and flux the surface of the brickwork. The inwall is the zone in which the blast furnace lining usually first begins to fail; the point of maximum erosion is about 20 to 30 feet above the mantle.

The top brick must withstand severe abrasion and the action of furnace gases at moderate temperatures. They must therefore be hard and tough, and refractory enough to resist abnormally high temperatures for short periods. Brick for the piping need to be amply refractory, and resistant to the abrasive action of dust laden gases and to rapid temperature changes. Brick of approximately inwall quality are generally used for the hot side piping and top quality for the cold side.

Stove brick in addition to serving as a thermal reservoir, must withstand temperature changes, considerable pressure, and often the fluxing action of dust. The brick should be sufficiently refractory so that they will not vitrify at the temperature of operation, as vitrification lowers their thermal value. The present tendency is to use throughout the stove only fire-brick of first quality. In many cases the denser brick are preferred.

Slow and thorough drying out of a new blast furnace lining is a matter of great importance, as too rapid heating up may seriously injure the brick work. The lining is protected somewhat by the carbon deposited upon the brickwork soon after the furnace is blown in. Among the operating conditions which may injure the lining are faulty distribution of stock, scaffolding and slips.

Open Hearth Furnace.

In basic open-hearth furnaces silica brick of the highest quality are used in the roofs, side and end-walls, ports and down-takes. The back and front walls are exposed to extremely severe conditions, and in stationary furnaces must be renewed two to three or more times during the life of a roof. They must resist high temperatures, the cutting action of flame, and the splashing of slag and metal.

The roof is usually 12-in. thick, but is often 9 in. or 13½ in. This is one of the hottest parts of the furnace; the temperature is at times high enough to cause molten silica to drip from the roof. The brick must have sufficient strength and rigidity at high temperatures to support the arch, and must resist the fluxing action of the basic oxides which are absorbed at the hot end from the furnace gases. The life of the roof in stationary basic furnaces varies from about 125 to 400 heats, depending upon the kind of fuel, type of furnace, and furnace practice.

Fig. 10, based upon the results of E. Rengade,† illustrates the manner in which open-hearth roof brick deteriorate in service. Four distinct zones are distinguished in brick which have been in service a normal period of time. The sketch illustrates the differences in appearance, crystalline structure and chemical composition of these zones. The most significant changes in the brick are the absorption of iron oxides

in acid furnaces, iron oxides and lime in basic furnaces; the migration of lime toward the center of the brick; and the development of tridymite at the hot end. The silica content of the zone showing the greatest impregnation by impurities may drop to 86 per cent or 87 per cent, as compared with an average of about 96 per cent for an unused brick.

Silica bulkheads are rapidly eaten away by the combined cutting and fluxing action of the dust-laden gases. In furnaces fired with oil or tar and coke oven gas a life of 60 to 120 heats for the silica bulkheads is not uncommon. In producer-gas fired furnaces the original bulkheads, when built of silica, usually last

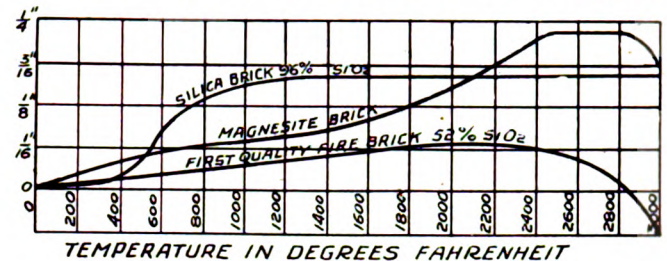


FIG. 9—Thermal expansion of refractory brick.

40 to 50 heats; thereafter repairs must be made after approximately each 15 heats. Metakase brick have been reported to give six to 10 times the life of silica brick in this part of the furnace.

The hearth of the basic open hearth is built up of magnesite brick and dead-burned magnesite, so laid that the brick are protected by a working bottom of granular material. The latter is mixed with 10 to 15 per cent of basic open-hearth cinder and sintered into place in layers ½ to 1 inch thick to a total depth of 12 in. to 18 in. at the center of the furnace. The bottom material must be extremely refractory and must fit together at high temperatures without fusion or excessive softening.

Calcined dolomites are extensively used for building up the banks between heats; dolomites sintered with a flux of some kind, are commonly used for patching basic bottoms and to a minor extent for original bottoms. The advantages of the sintered dolomites are their low first cost and their more rapid setting properties when thrown into a hot furnace. They are much less resistant than dead-burned magnesite to atmospheric slaking, and to slag-action. In a number of cases dolomite bottoms after a comparatively brief shut-down of the furnace, have completely disintegrated to powder.

Chrome brick were at one time almost invariably used between the silica and magnesite brick in the walls, and this is undoubtedly good practice. However, many open hearth furnaces have dispensed with them. Lump chrome ore is frequently employed for building up the slopes and blocks at the ends of the furnace. Walls are often daubed with finely ground chrome ore from the slag line to the skew-line. If the ore is too refractory it will not stick. A suitable ore is somewhat plastic and remains in place until set.

The regenerators are usually of first quality fire brick throughout. Some are first quality firebrick except for the top 10 to 12 courses, which are silica. The temperatures, particularly at the top of the checkers, may be at times fairly high. The gases always carry dust which tends to flux the checkers and to

*P. O. Menke, Disintegration of Blast Furnace Linings, Iron Age, 109, 528 (1922).

†Academy of Science, Paris, 1918. Quoted by W. F. Rochow, Jour. Ind. Eng. Chem., II, 1146 (1919).

choke up the openings. The checkers must be capable of quickly absorbing and giving off heat; of withstanding fairly high temperatures without vitrification; and of resisting rapid temperature changes and fluxing action.

The chief difference in construction between the acid and basic open-hearth furnace is the character of the hearth. In the acid furnace the hearth consists of silica sand sintered into place over silica or clay brick, preferably the former.

In a construction of a 50-ton basic open-hearth furnace, approximately the following amounts of refractory material are required:

Silica Brick, 15,000 9-in. equivalent.

First quality clay brick, 250,000 9-in. equivalent.

Magnesia brick 20,000 9-in. equivalent.

Second quality clay brick, 50,000 9-in. equivalent.

Dead-burned magnesite 75 tons.

Other Furnaces in Iron and Steel Industry.

On account of the limitations of space, other furnaces will not be discussed in detail, but brief reference will



FIG. 10—Magnesite quarry at Veitsch, Austria.

be made to the conditions affecting refractories in certain types of practice.

Practice in many heating furnaces is severe on account of the intense heat and rapid variations in temperature. These furnaces are commonly built of clay brick. In the lower part of certain heating furnaces, where corrosive iron scale collects, magnesia and chrome brick have been used with good results.

In no industrial service is practice more severe than in malleable iron furnace, particularly upon the bungs. Bungs are often removed while hot and set on the floors or while cold are placed on the furnace at white heat. The sidewall brick are destroyed by fusion and by scouring action of the slag. According to Schurecht* bung brick must be strong enough to support the load; they may have fairly high shrinkage in the standard load test of 25 pounds per square inch at 1350 deg. C., but should show low loss in the spalling test.

*H. G. Schurecht, Bricks for Malleable Furnaces, The Foundry, September 1, 1922.

In boiler furnaces firebrick are used for the walls, arches, and baffle tile. The sidewall brick of coal fired boilers are subjected not only to high temperatures, but also to the action of the clinker, which may fuse and flux the brickwork; and to rough treatment from the poker and slice bar as the clinker is removed. The clinker may stick very strongly to the brick, and when it is removed part of the brick may come with it. Certain types of clinker adhere less firmly to high-alumina brick than to clay brick. For sidewall service dense hard burned brick are often economical.

The boiler arch in some types of boilers must withstand even more severe conditions than the sidewalls. The temperatures reached are often very high, and the under side of the arch is exposed to the cutting action of hot gases at high velocity, carrying particles of fuel dust and ash. The main causes of trouble with firebrick arches are excessive temperatures, resulting from insufficient radiation or too little draft; or excessive temperature changes, brought about by the inrush of cold air. The first condition causes softening; the second, spalling.

FUSING POINTS OF SEGER CONES

No. of Cone	Fusing Point Original Scale		No. of Cone	Fusing Point Original Scale		Revised Scale*	
	Deg. F.	Deg. C.		Deg. F.	Deg. C.	Deg. F.	Deg. C.
.022	1,094	590	10	2,426	1,330		
.021	1,148	620	11	2,462	1,350		
.020	1,202	650	12	2,498	1,370		
.019	1,256	680	13	2,534	1,390		
.018	1,310	710	14	2,570	1,410		
.017	1,364	740	15	2,606	1,430		
.016	1,418	770	16	2,642	1,450		
.015	1,472	800	17	2,678	1,470		
.014	1,526	830	18	2,714	1,490	2,714	1,490
.013	1,580	860	19	2,750	1,510	2,750	1,510
.012	1,634	890	20	2,786	1,530	2,786	1,530
.011	1,688	920	21†	2,822	1,550		
.010	1,742	950	22†	2,858	1,570		
.09	1,778	970	23†	2,894	1,590		
.08	1,814	990	24†	2,930	1,610		
.07	1,850	1,010	25†	2,966	1,630		
.06	1,886	1,030	26	3,002	1,650	2,912	1,600
.05	1,922	1,050	27	3,038	1,670	2,948	1,620
.04	1,958	1,070	28	3,074	1,690	2,975	1,635
.03	1,994	1,090	29	3,110	1,710	3,002	1,650
.02	2,030	1,110	30	3,146	1,730	3,038	1,670
.01	2,066	1,130	31	3,182	1,750	3,065	1,685
1	2,106	1,150	32	3,218	1,770	3,101	1,705
2	2,138	1,170	33	3,254	1,790	3,128	1,720
3	2,174	1,190	34	3,290	1,810	3,164	1,740
4	2,210	1,210	35	3,326	1,830	3,191	1,755
5	2,246	1,230	36	3,362	1,850		
6	2,282	1,250	37	3,398	1,870		
7	2,318	1,270	38	3,434	1,890		
8	2,345	1,290	39	3,470	1,910		
9	2,390	1,310					

*U. S. Bureau of Standards, Washington, D. C.

†Cones 21 to 25 inclusive, all come down at practically the same temperature.

Sale of Seized Ruhr Steel

Mineral ore, crude, semi-finished and finished iron and steel seized in the Ruhr and held by Franco-Belgian regie, are said to have totaled between 500,000 and 600,000 tons, Commercial Attache C. L. Jones informs the Department of Commerce. The French iron and steel industry has been very anxious to avoid any repetition of a weakened market such as occurred in several lines during the disposal of the war stocks.

SHEET AND TIN PLATE

Within One Hundred Mile Radius

This Year's Developments Make Granite City a Self
Contained Steel Empire

By F. J. CROLIUS

PART II

THEY have broken many records at National Enamel during the last busy 12 months and have added several very important pages to the history of the steel industry.

1. Illinois Coal has been successfully coked in by-product ovens.

2. A new 100-in. motor-driven plate mill has been put in operation, and has rolled the first plate made entirely from materials assembled within this 100 mile radius.

3. One of the largest and the most modern sheet mills has been completed and put in operation.

4. The foundations for a new empire of steel have been carefully laid, upon which there need be no limits of expansion.

In our October issue, the history of the famous Iron Mountain ore field, so important to this development was interrupted.

Iron Mountain Resumes Production.

The restoration of the world famous Missouri Iron Mountain to the ranks of producing ore properties through the faith, enterprise and energy of Leonard A. Busby of Chicago is in the act of accomplishment. The fifty-year charter of the historic Iron Mountain Company expired in 1919; it was renewed under the same name by Mr. Busby within 12 months of its expiration. A short period of operation on a small scale having satisfied him that uniformity of product could not be assured without milling, ground was broken for a 2,000-ton mill about six months ago. The mill is now in operation. It is probable that by the time this article falls under the eye of the reader the output will have reached 10 or 12 40-ton cars of 56 to 60 per cent concentrates per day, and that within a few months it will go to 1,000 tons. The total investment thus far in the rejuvenation of this famous property is about \$600,000.

"Too much credit," said George W. Niedringhaus, president of the National Enameling and Stamping Company, "cannot be given to Mr. Busby, the owner of Iron Mountain. He had courage to first explore the iron possibilities of this property. Disregarding the failure of others in the old company and the adverse reports of former examiners, he employed geologists and engineers to go over the territory, and after he had finally settled upon a plan of operation submitted it to the criticism of the country's foremost experts. The mill embodies the result of the latest

research and experience in the field of ore concentration; it was built by a firm of engineers—Roche & Stoddard—specialists in this particular field.

1,000 Tons Per Day.

"It is expected that later this year the mill will be turning out 1,000 tons of concentrates per day. The importance of this to the iron and steel industry of St. Louis can hardly be overestimated. This famous old property produced in the past about 4,000,000 tons of ore. The peak year appears to have been 1869, when the production was 269,000 tons. The ore is of the highest quality. A specimen which I picked

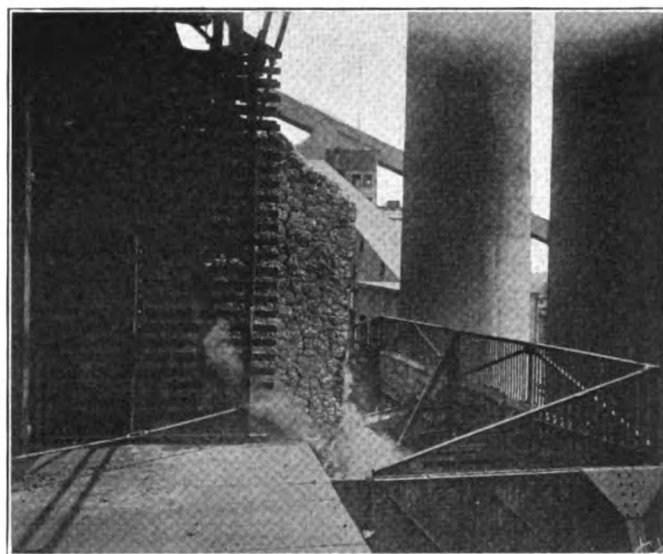


FIG. 10—A fine view of the coke mass just as it leaves the oven when pushed.

up there on the occasion of a recent visit assayed 66.26 per cent metallic iron and 6.1 per cent silica, with negligible quantities of phosphorous and sulphur. This development opens a tremendous body of Missouri ores."

This new enterprise may be hailed as one of the "by-products" of the successful coking of Illinois coal by the use of the Roberts Oven. It was under the inspiration of the success of Mr. Niedringhaus, Mr. Maguire and their associates that Mr. Busby was led to purchase the Iron Mountain property and subject it to the searching examination which supplied the warrant for its development. The tremendous eco-

nomic importance of this source of ore to the St. Louis iron and steel district cannot be measured simply in terms of the great superiority of Iron Mountain ores to those of the Northern Ranges. The flat rate of 90 cents per ton brings this ore into the St. Louis market. This may be contrasted with the rate of \$2.93 on Northern ores.

In order to understand what is happening at Iron Mountain today it is necessary to go back some 50 or 60 million years to what geologists call pre-Cambrian times. At that distant period a thick deposit of igneous rock, known as black porphyry, was formed where the St. Francois Hills now stand in Southern Missouri. The tremendous forces which work within the interior of the earth labored again after this black porphyry was made and a passage for fiery molten rock was broken part way through the mass. The



FIG. 11—Shows the open-hearth department. From an original steel making unit of two 25-ton openhearth furnaces—the present capacity has expanded to ten 65-ton furnaces—with a monthly production nearing 40,000 tons of basic steel. In this mill was developed the reversing valve, now in general use through Blake-Knox & Company. Fuel oil is fired at all open-hearth furnaces, and five furnaces are connected to 250 hp. Wickes vertical boilers—equipped with super-heaters. Oil is kept within narrow temperature range 145 deg. in the pre-heaters—and atomized with superheated steam—burned through burners of local design. Average consumption approximates 42 gallons per ton of steel.

ascending rock never reached the surface but it did find a weak place within the black porphyry formation, lifted the upper part of it and so formed an enormous rock "cistern" whose shape was like that of two rather shallow bowls placed rim to rim, one turned upside down on top of the other. Under its covering this molten mass hardened into a vast cunk of red porphyry several thousand feet in diameter. In course of time the black porphyry, which overlaid it, was worn away by wave and stream and the red porphyry was exposed—a low dome-shaped island rising out of the Cambrian Sea.

Three Sources of Iron Ore.

Now as this mass cooled some interesting things took place within it. Scattered all through it were flecks of iron; and in obedience to a chemical law which operates to gather free particles of the same substance in a melted mass together, these particles

of iron found each other, until at intervals within the porphyry there were formed great irregular shaped masses of ore. Meanwhile the waves of the Cambrian Sea were pounding away at the rounded summit of this red island, so different from the islands of black porphyry which surrounded it. The chemical action of water and air was decomposing the porphyry. Some of its constituents were dissolved and carried away, but the masses of iron which it contained rolled down the slope of the island in the water and were cemented together, forming a conglomerate. Following this, beds of limestone and sandstone were laid down in a series reaching nearly, but not quite to the top of Iron Mountain Island. When the sea went back for the last time and the whole process came to an end, there was a country of rolling hills of black porphyry, limestone and sandstone, in the midst of which was a hill of red porphyry rising above the sandstones and limestones lying upon its flanks. There were three sources of iron ore there; exposed boulders on top of the hill, the irregular masses, large and small, scattered through the porphyry, and the rich boulders of the conglomerate mantle between the porphyry and the surrounding sandstone and limestone.

Just 78 years ago, in 1845, James Harrison and Conrad C. Ziegler formed the American Iron Mountain Company, which built a plank wagon road from Iron Mountain to Ste. Genevieve, 42 miles away, on the Mississippi. The first source of ore was the boulders which had weathered out of the porphyry. A day laborer could pick up from six to eight tons a day and the ore was worth \$9 to \$10 a ton. Later a reservoir was built on top of a neighboring mountain and lines of charcoal-iron pipe brought the water to Iron Mountain under a pressure of 150 pounds to the square inch. There great nozzles, called "monitors," were turned against the weathered porphyry and the hill was torn away; the lighter rock being washed down the gullies and the iron left behind.

The high quality of this ore made it greatly in demand. The original Iron Mountain Railroad was built to haul it to St. Louis. As the ores of Northern Pennsylvania and Southern New York grew poorer and poorer, Iron Mountain ore was shipped to the Carnegie Steel Company from Ste. Genevieve in barges, which went down the Mississippi and up the Ohio in order to enrich the mixture in the Pittsburgh furnaces. These barges were loaded with coke for the return trip, and thus the fuel for the 10 stacks then making iron in St. Louis were supplied. Their capacity was 1,350 tons of pig iron a day. The ores from Iron Mountain were reinforced in these days by the ores from Pilot Knob, Cherry Valley and other Southeast Missouri mining centers. When the reader recalls that the total ore production of the United States was only 3,000,000 tons in 1870, it will be seen what enormous importance an output of 200,000 or 300,000 tons per year of high grade ore assumed. (In 1920 the output of the United States was 69,500,000 tons; but that is another story.)

When Production Stopped.

The story of the startling end of ore production under the old company was once related to the writer by Charles W. Knapp, who was editor of the paper that published it to the world—the old St. Louis Republic. A mining man of good standing and repute gave to the Republic the news that Iron Mountain

had shut down production not to resume. The paper published the news the next morning and it was scattered broadcast over the United States. One of the owners of the mine came to Mr. Knapp and protested bitterly, demanding redress. Mr. Knapp replied, "Very well, we desire to rectify any mistake which we have made. You choose a mining engineer and I will choose a mining engineer; then let these two men select a third. Let them make a careful examination and the Republic will publish the results. If this examination substantiates our account of the matter you will bear the expense; if we prove to have been wrong, we will bear the expense and give the fact of our mistake the widest publicity." The owners of the Republic never heard of the matter again.

At this distance of time it is interesting to note that if Mr. Knapp's offer had been accepted the whole history of the iron industry in Missouri might have taken a different course.

With 2,000,000 Tons in Sight.

Because: It is evident today that the serious factors in the situation were not physical. It is estimated by engineers that the merchantable ore now actually in sight in the "big cut" on top of the mountain will measure at least 2,000,000 tons. Five factors conspired to close Iron Mountain down. Two were metallurgical—the handicap under which the industry

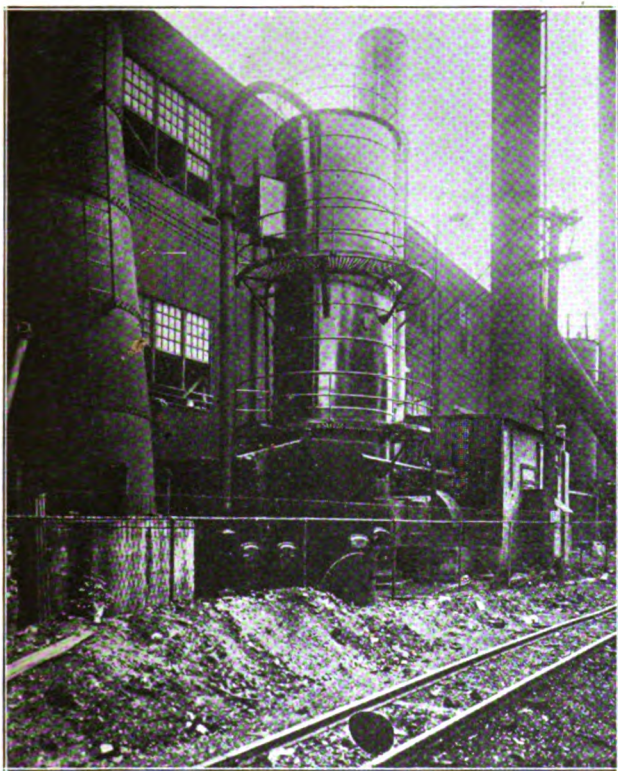


FIG. 12—An excellent view of one of the vertical water-tube waste heat boilers.

had always labored, because of the lack of metallurgical coke in Missouri and the further fact that the mining of the rich surface deposits had proceeded so far that the economical handling of the deeper ores called for largely increased investments in underground workings and mill equipment. Two were commercial—a very low price for pig iron coincided with the first great discoveries on the Northern ranges, where rich

ores were being scooped up with steam shovels at the surface of the ground. One was human—the men controlling Iron Mountain at that time were old and had reached the period of abundant wealth and relaxed effort. So it came about that through the lack of metallurgical fuel, the need for larger investments in mining and milling equipment, a sagging iron market, new discoveries in the North and the relaxation

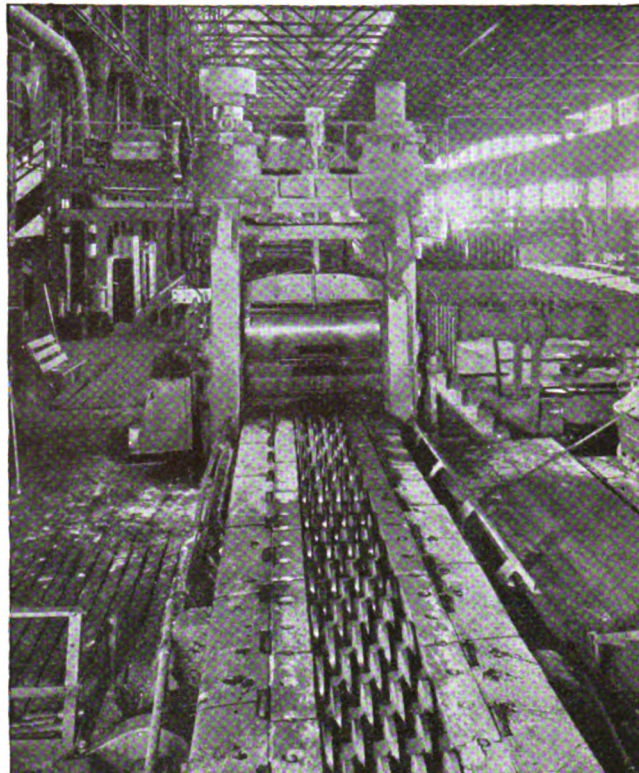


FIG. 13—The new 100-in. plate mill, showing run out tables.

of effort which comes with wealth, leisure and approaching old age, the Iron Mountain of Missouri, which had been advertised by every school geography in the land as "sufficient to supply the needs of the world for 20 years," passed into the realm of tradition without the expenditure of the time and money necessary for a thorough determination of the actual situation. While mining engineers of the highest standing looked over the property they were forced to confine their reports to things immediately in sight; later, owners delving among the records of the old company were unable to find anything that would cast any light on the full extent of the deposit, now estimated at 20,000,000 tons.

Three years ago the Iron Mountain property was acquired by Leonard A. Busby of Chicago, president of the Chicago Surface Lines. The successful coking of Illinois coal had become a reality; the development of the iron and steel industry of Missouri was responding to the new impulse of a new opportunity. (A pleasing legend has obtained a certain currency to the effect that Mr. Busby was in quest of a cow pasture when he made his purchase and afterward discovered that the tract included the most widely celebrated iron property in the world. Those in search of the picturesque are privileged to believe it.)

A 2,000-Ton Mill.

Today a plant capable of milling 2,000 tons of rock a day has begun operation within a few yards of the

old Iron Mountain plant. A double compartment shaft, each side 5 x 6 feet, has been sunk to a depth of 329 feet. A powerhouse nearby contains two 520 hp., oil burning, Diesel engines made by the Fulton Iron Works of St. Louis, and the economy and efficiency of these motors when operating compressors and mills of moderate size makes the observer wonder whether Diesel engines whose power will be rated in thousands of hp. may not be just around the corner of the future. The mill is frame construction covered with corrugated iron. Aluminum paint has been used on the inside with excellent results as to diffusion of light; all exposed frame work about the plant has been made of treated timbers. The mill foundations are reinforced concrete and are very heavy. All the heavy machinery is on the ground floor; there are no crushers or rolls carried on high frames or "hung up on a nail." Short elevators are used to handle the material from one step to another.

The ore from the self-dumping skips as it comes from the shaft goes to a "picking table" where the large boulders of pure ore are taken out for use in open hearth steel furnaces. The rest is treated by a series of jaw crushers, rolls, jigs and water tables. When reduced, the concentrated material is about two-thirds of the original weight as hoisted, the silica and porphyry being eliminated. The concentrates are guaranteed to contain more than 56 per cent metallic

iron, and less than 6 per cent silica, .2 per cent sulphur and .05 per cent phosphorus. The mill, which will recover 90 per cent of the ore in the rock, will only require the services of five or six men; about 200 men work in the ground when the mine is under full operation. The tailings, of which several hundred tons a day will be produced when the mill comes to full operation, will undoubtedly have a unique value for road making, as the small amount of iron which they carry will assure their cementation into a consolidated mass of even texture.

Adopting South African Methods.

The plant is being operated under the direction of W. T. May, general manager, a Canadian, whose degree in mining engineering was taken at McGill University, and A. S. E. Corbett, underground superintendent, a South African engineer whose technical training and early experience were obtained in the district of the Rand. It is interesting to note here that the results of the South African experience have been made use of at more than one point in the operation of the Iron Mountain plant. Kimberley skips carry the ore in the shaft, while the method of handling adopted underground is adapted from the famous Modder B Mine at Johannesburg.

The problem of underground handling confronting the Iron Mountain property was extremely difficult.

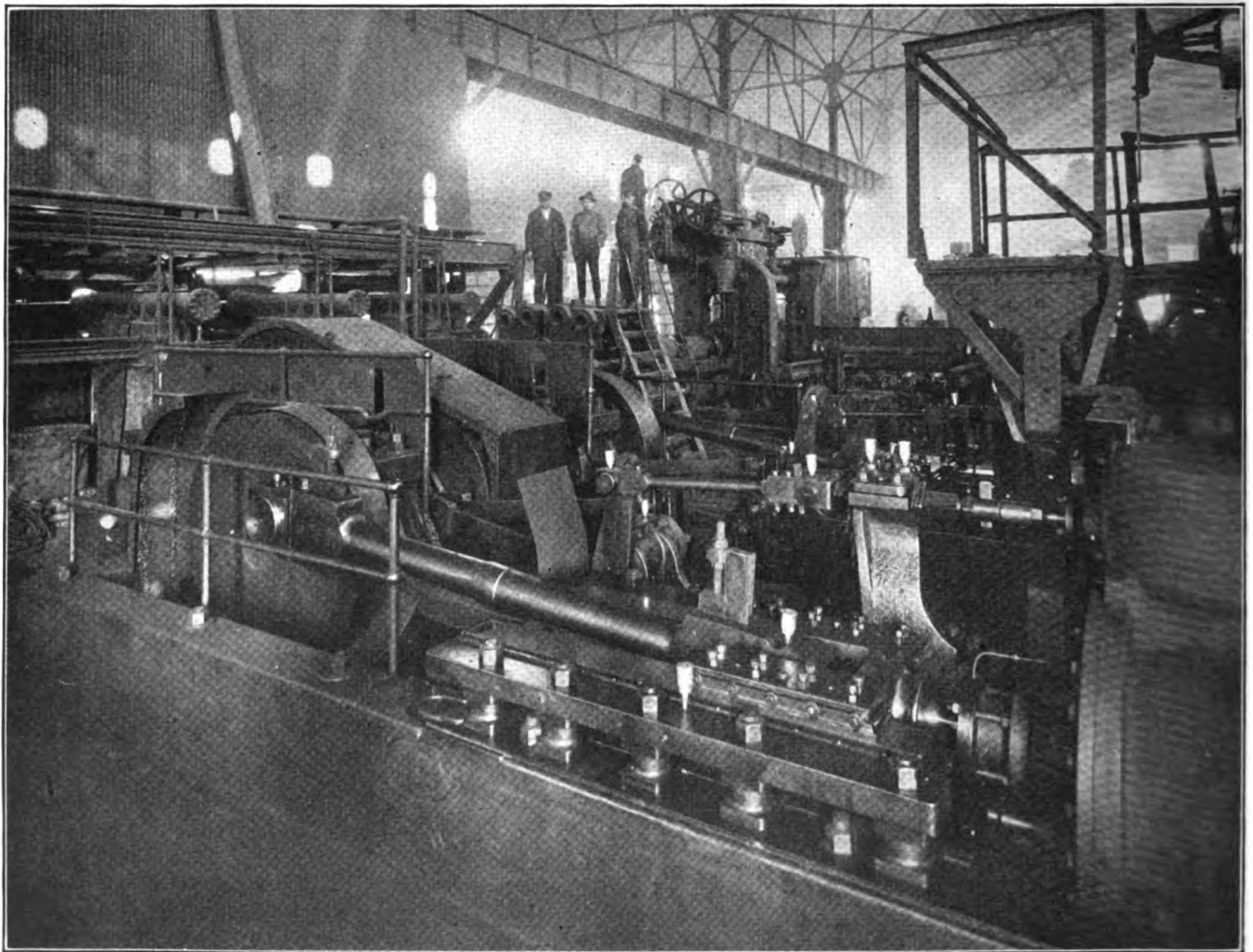


FIG. 14—View of 26-in. x 48-in. double reversing engine driving the new blooming mill—with mill showing in background.

The present underground workings are in the iron boulder-conglomerate formation which had its origin as noted above when the waves of the Cambrian Sea were tearing at the upper portion of Iron Mountain Island and the heavy boulders of iron were rolling down into the still water then surrounding its sloping sides. This deposit has an inclination of about 35 deg.—too steep to run cars on and not steep enough to make the ore slide in chutes. The hanging wall above is of limestone. The foot wall below is the red porphyry mass of Iron Mountain. The problem has been solved by General Manager May and Superintendent Corbett in South African fashion. Below the ore deposit they have cut a tunnel 1,500 feet long, straight through the porphyry mass. (They encountered a 224-foot ore body in so doing whose other dimensions are as yet unknown, but that is another story.) If you could fancy yourself walking in a long, narrow passage in the basement of a building and knowing that the gently curving surface of a vast dome was somewhere above your head, you could conceive the relation of this drift through the solid rock to the ore-boulder conglomerate above.



FIG. 15—The new bar-mill, which is a record tonnage producer.

From this passage at intervals vertical chutes rise to the ore—holes in the ceiling through which anything might drop straight down. There is one of these chutes from above for each division of the ore body; the divisions are 400x 500 feet with a thickness averaging something over five feet; the thickness varies from nothing at all to 30 feet. The ore is transported a short distance to the nearest chute; there it is dumped into a car in the horizontal passage below from which it is hauled to the foot of the shaft.

Operations at Granite City.

On pages 535-537 in October, were shown views of the new 500-ton blast furnace, and of the coke ovens. The monthly production of iron averages over 15,000 tons with an average coke consumption less than 1,800 lbs. per ton. There are 80 Roberts ovens, with a daily capacity of about 2,100 tons of Illinois coal from which are recovered the metallurgical coke, the resultant tar, benzol, sulfate of ammonia and by-product gas. Fig. 10 shows an excellent view of coke being pushed.

The iron used for steel making is conveyed from the blast furnace in hot metal ladles.

Nothing but open hearth steel is used in the sheet, plate and bar mills.

There are ten 65-ton open hearths, five of which are equipped with Wickes water-tube boilers. Fig. 11 shows a view of the charging floor in the open hearth mill, and Fig. 12 shows the excellent arrangement of waste-heat recoveries through vertical boilers.

The new 100-in. plate-mill is an interesting installation. Fig. 13 shows this mill and run-out tables.



FIG. 16—Group of tin-mills.

The top and bottom rolls of this mill are 34-in. diameter, the middle roll 22-in. diameter, and the face width of all three is 100-in. Plates from No. 10 gauge to 1¼-in. thickness are rolled.

The main feature of the middle roll operating rig is the ease with which roll changing is accomplished. In this design, the arms carrying the middle roll, are hydraulically operated, and without being removed from the mill, are disengaged from the roll and rocked back from the mill towards the table, leaving the entire window opening unobstructed.

The top roll is balanced by means of a hydraulic cylinder placed above and connected to the balance beam and roll bearings by easily removable hanger bars.

A 60 hp. motor is required for the screw-down, which is of the worm and worm wheel type. In order

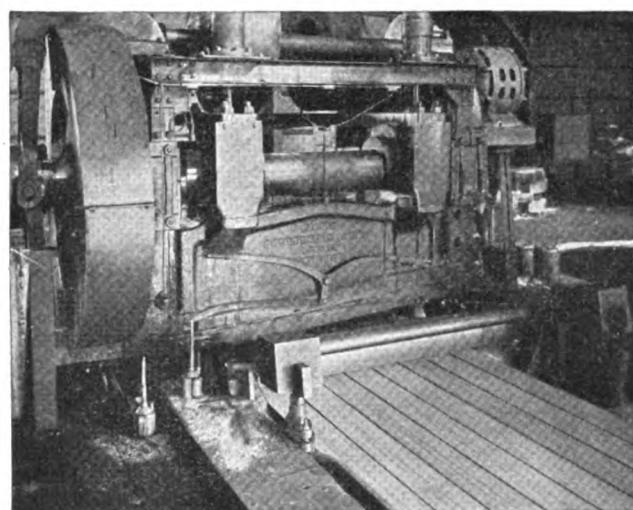


FIG. 17—The heavy duty slab shears.

to keep the opening between the rolls uniform from end to end and thus insure uniform thickness of plate, a clutch is used in the worm shaft so that one screw may be operated independently of the other. This adjustment must be close and be made frequently and an

hydraulic cylinder permits operation of this clutch by simply opening a valve placed in the pulpit or other convenient location.

An 8-in. accumulator of about 5-foot stroke to maintain 500 pounds per square inch water pressure, is furnished for the operation of the cylinders.

The pinions are cut with double helical teeth and

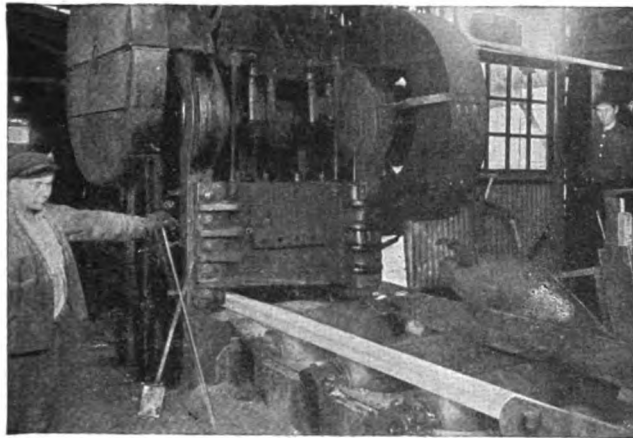


FIG. 18—High capacity bar shears.

arranged so that $4\frac{1}{2}$ to 1 speed reduction is attained, eliminating a separate gear reduction set, and, therefore, considerably reducing the floor space.

The heavy fly wheel provided to take care of the main peak load, is cast steel of the umbrella or mushroom type and a Tod type universal spindle connects it to the main driving pinion. The fly wheel is connected to the motor by a flexible coupling. The motor is 3000 hp., 2200 volt, 3-phase induction type with a speed of 235 rpm., giving a mill speed of 52 rpm.

In the three-high plate mill the slab is passed first between the bottom and middle rolls, with the middle roll held up against the top roll by the aforementioned operating rig; the middle roll is then lowered and the piece raised by the table and passed back between the top and middle rolls, the middle roll being in contact with the bottom roll. The middle roll is then raised, the tables lowered, and another bottom pass made. This is repeated until the plate is of desired thickness. To accomplish this raising and lowering of the piece, tilting tables are used. The table girders are rolled steel slabs machined to an "I" section. Each of the tilting tables is 27 ft. 6 in. long with 17 disc type rollers, driven by an 80 hp. motor. The mitre gears are forged steel with cut teeth. There is but one lineshaft and one motor on each table. This arrangement is suitable to a tandem mill, since the roughing stand elongates the slab sufficiently to permit wider spacing of table rollers than in ordinary plate mills. The tilting tables are roller bearing equipped.

These tables are operated by a patented "Air Hydraulic" system. The ends farthest from the mill are supported on massive rocker stands on trunions, while the mill end is carried on levers mounted on shafts. By means of hydraulic cylinders, operating through levers on the outer ends of these shafts and connected by a link, the tables are balanced.

These cylinders are piped to a vertical tank partially filled with water. The upper end of this tank carries air at a sufficient pressure to balance the tables

in mid-position. Two series connected 100 hp. motors, geared to the lever mechanism, serve to operate the tables. When lowered, the water is forced from the cylinders into the tank, further compressing the air. This results in an over-balance, cushioning the tables at the bottom of their down-stroke and relieving the motors of part of their work in starting the up-stroke. As they rise, the pressure lowers, retarding them towards the end of the stroke and leaving them underbalanced. This under-balance operates to help start the tables downward.

Two plate shears are included. One is a No. 6, 108-in., with a capacity to cut $1\frac{1}{8}$ -in. plate and the other a No. 4, 156-in., for cutting $9/16$ -in. plate. These shears are equipped with oil gauge, but are so arranged that magnetic hold-downs may be added.

The total weight, exclusive of motors, amounts to nearly two million pounds.

The new 100-in. is the second plate mill at Granite City—the older and smaller mill being a two-high 34-in. Universal mill.

Slabs have been supplied from the 34-in. blooming mill—which is engine driven by a 26-in. x 48-in. double reversing engine.

Fig. 14 is an excellent view of this reversing engine, with mill in the background.

The other important mill units are the 34-in. Universal mill—engine driven by a 30-in. x 48-in. double reversing steam engine, the new bar mill which is

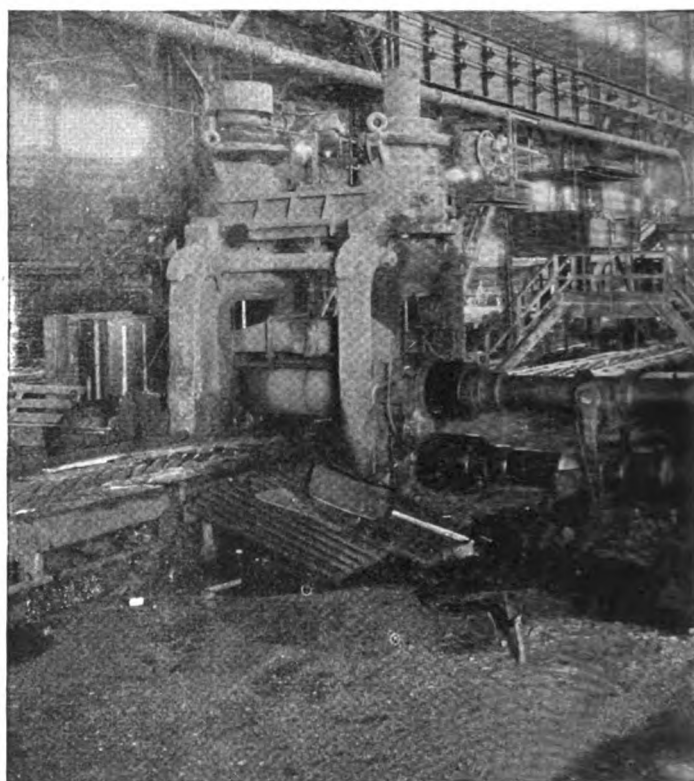


FIG. 19—34-in. Blooming Mill.

shown in Fig. 15 and the group of sheet and tin mills shown in Fig. 16.

Figs. 17 and 18 show the excellent shearing facilities.

Fig. 19 gives a comprehensive idea of the 34-in. blooming mill.

(Continued in December)

What It Costs To Make Tin Plate

Cost of Erecting and Operating a 10,000-Ton Plant in This Country and Wales

Reprinted from The Metal World of October 20, 1894

THE Metal World has received a large number of inquiries from prospective investors in tinned plate manufacture during the past five months, or ever since it became a certainty that the duty would be reduced. These inquiries all want to know whether or not it is possible to manufacture tinned and terne plates in this country in successful competition with British makers, under the duty fixed by the Wilson bill, as amended by the Senate, viz., 1 2/10 cents a pound. The Metal World has taken considerable trouble to get the information desired, and it is herewith presented for the benefit of all readers, with

This article, taken from the personal files of Mr. Niedringhaus, is an interesting page from The Metal World of November 20, 1894: Mr. B. E. V. Luty, an authority on sheet and tin plate, was at that time manager of The Metal World; he is a regular contributor to the Blast Furnace and Steel Plant.

As an evidence of the many changes which have been recorded during the development of tin plate into an American industry, this schedule of costs bears striking witness. The closing paragraph is significant.

the assurance that the figures are as accurate as it was possible to get them. They were obtained by a gentleman who contemplated investing in the tinned plate industry on a large scale, but wished to have information of a character which he found it impossible to obtain without visiting Wales to ascertain the relation of costs of manufacture there and in this country. He compared the costs of a 10,000-ton plant there and here, and here are the figures he has permitted The Metal World to make public, for the benefit of its readers.

COMPARATIVE COST OF ERECTING A TIN PLATE PLANT IN THE UNITED STATES AND WALES

	U. S.	Wales	Difference
Total cost of 10,000-ton plant, complete	\$400,000.00	\$280,000.00	\$120,000.00
Necessary working capital to carry stocks, credits and current accounts...	150,000.00	80,000.00	70,000.00
Totals.....	\$550,000.00	\$360,000.00	\$190,000.00
Interest on capital, U. S. 6%, Wales 3%	\$ 33,000.00	\$ 10,800.00	\$ 22,200.00
Difference on interest charges per ton of finished product			2.22
Cost of repairs, depreciation of plant, etc., as per estimate of experts in both countries, 10% ...	40,000.00	28,000.00	12,000.00
Difference per ton on finished product			1.20
To make 10,000 tons of tinned plate will require 12,500 tons of steel billets, the import duty on which is, as per Senate tariff act, 3-10c per pound or \$6.72 per ton, on 12,500 tons \$84,000.			
Per finished ton of tinned plates.....	\$ 8.40		

The advantage the British manufacturer would have over a new beginner in the United States on account of longer experience in manipulating men, materials and markets is, as estimated by a careful and experienced Welsh manufacturer, per ton..... 2.00

The freight rate from Swansea or Liverpool to the principal tinned plate consuming markets in the United States, east and west, averages 10c per 100 pounds lower than from the chief centers of American manufacture to the same points. This amounts to, per gross ton

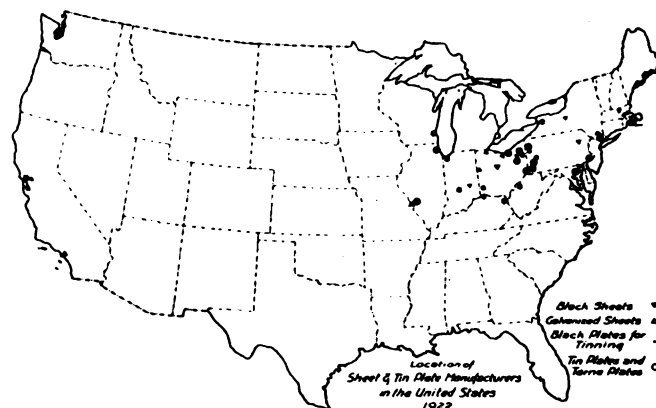
\$16.06

COMPARISON OF WAGE COSTS—UNION WAGES

Bar Mill—

	U. S.	Wales	Diff.
Billet heater and 2 helpers.....	\$.80	\$.36	\$.44
Bar roller 37			
Hooker, catcher and bloomboy 30	1.12	.40	.72
Bar shearman and wheeler 45			
	\$1.92	\$.76	\$1.16

Add 20 per cent for cost of labor and material which goes to waste in shearing in tinning.....	.38	.13	.25
	\$2.30	\$.89	\$1.41



Location of the sheet and tin plate mills in the United States.

Tin Rolling Mill—(No. 31 Gauge)

	U. S.	Wales	Difference
Rolling and catching.....	\$ 5.40	\$ 1.90	\$ 3.50
Doubling	2.84	1.10	1.74
Shearing	1.78	.50	1.28
Heating	2.66	1.05	1.61
Opening	.80	.32	.48
Pickling, black and white.....	1.54	.45	1.09
Annealing	1.00	.34	.66
Cold rolling	1.00	.43	.57
	\$19.32	\$ 6.98	\$12.34

Add 2½ per cent for labor and material which goes to waste in pickling	.48	.17	.31
	\$19.80	\$ 7.15	\$12.65

Tin House—(22 4/10 boxes to ton)

	U. S.	Wales	Difference
Tinning	\$ 2.68	\$ 1.34	\$ 1.34
Washing	2.68	1.34	1.34
Catching	.90	.45	.45
Branning	1.56	.60	.96
Dusting	1.34	.50	.84
Assorting	.90	.36	.54

Reckoning and weighing.....	.08	.04	.04
Boxing	.25	.11	.14
Overseeing	.22	.11	.11
Day labor	8.75	4.40	4.35
	\$39.16	\$16.40	\$22.76

Total advantage of British over American manufacturer, per ton \$38.82

The presentation of figures shows, that in order to make the investment safe, the manufacturer needs a protective duty at the seaboard of $1\frac{3}{4}$ cents a pound. Regarding the item for duty on steel billets, while the full amount of the duty is given, in reality the price quotations from American billet makers are only \$1.00 per ton higher on Bessemer billets than the British quotations, but on Siemens-Martin, or open hearth billets, it is \$4.00 higher than the quotations of British makers; therefore, on this item the advantage to the British manufacturer would be reduced.

Advantage of British maker.....	\$37.82
On Bessemer billets.....	7.15
	\$31.67
On open hearth.....	38.82
Less	3.40
	\$35.42

As a factor of safety, the duty on tinned plates should not be less than as stated above, $1\frac{3}{4}$ cents per pound, because there is a risk that in better times and a more prosperous condition in the iron and steel industries, the price of American billets will again advance to the importing point. The duty as fixed in the present tariff law is scarcely adequate, because—2,240 lbs. tinned plate at $1\frac{2}{10}$ cents equals \$26.88—when the British manufacturer has an advantage over his American competitor in one case of (Bessemer) \$31.67, and in the other (open hearth) of \$35.42, or \$4.79 and \$8.54, respectively. Insurance, bad debts, commissions and managerial expenses are not computed in this calculation.

There is, however, another factor which applies to the production of tinned plates by a number of the most extensive of the British manufacturers, viz.: Many of them make their own open hearth steel billets, and the difference between the cost to them and the price they would pay if they bought them, otherwise the profit of the billet manufacturer is carried over to the cost of the finished tinned plate, and the profit is distributed over the various processes of manipulation and reckoned in the aggregate, when the latter are disposed of. By reckoning a very small profit on the finished material as it passes from one process of manufacture to another, there being no division of profit throughout the entire series of processes, the aggregate profit is sufficiently remunerative to justify a large production, even at a selling price others could not meet.

The Metal World is enabled to present these figures because the gentleman from whom they were obtained has concluded to postpone investment in tinned plate manufacture until such time as the prospects of profits are more auspicious.

Sheet Mills Quiet

Mill operations next week will reflect the slackness of demand for steel and be lower than at any time this year. With the exception of the U. S. Steel Corpora-

tion's plants, which are still maintaining a high operating ratio, independents have reduced operations to a point closer to the volume of incoming orders.

The sheet business is especially dull. Most of the mills have taken some Japanese orders, which are not very profitable, but serve at least to keep the mills busy.

The result of reduced requirements for semi-finished steel is the curtailment in steel output. During the next week but 35 of the 52 independents' open hearth furnaces will make steel, and all of the Bessemer plants will be blowing. The production of the latter, however, is kept below capacity through reduced working time or reduced number of heats.

A survey of iron making shows 2 of the 46 stacks on the active list. The latest furnace to go down was the Grace at the Brier Hill plant of Youngstown Sheet & Tube Company. There is little likelihood that merchant furnaces which had been banked in September and October will resume unless there is a decided change in market conditions.

Of the 120 independent sheet mills in the district 74 are on the active list.

Individual Operations.

Youngstown Sheet & Tube (including all the Youngstown district plants): Five blast furnaces, 13 open hearth, Bessemer, two plate mills, two merchant bar mills on single turn, 17 sheet mills (12 at East Youngstown and five at Western Reserve), four skelp mills, 10 tube mills, rod and wire department and puddle furnaces.

Republic Iron & Steel: Four blast furnaces, 10 open hearths, Bessemer, plate mill, two light bar mills, two skelp mills, six tube mills and eight sheet mills.

Trumbull Steel: One blast furnace, seven open hearths, strip mills about 80 per cent capacity; 15 sheet mills, 25 tin mills.

Sharon Steel Hoop: One blast furnace, five open hearths, four strip mills, and six sheet mills.

A. M. Buyers: About 82 puddling furnaces and two skelp mills.

Newton Steel has 14 sheet mills, Falcon Steel eight sheet mills and Mahoning Valley Steel six sheet mills under power.

Corporation Operations.

Plants of the Carnegie Steel Company in this district are operating at average of about 80 per cent of capacity. At the Ohio Works six blast furnaces, Bessemer and 13 open hearths are in operation besides the blooming mills. At the New Castle plant two of the four stacks, Bessemer and bar mill are in operation; at Farrell plant three blast furnaces and 14 open hearths and the bar and skelp mill are in operation. The 17 bar mills located at the McDonald and Union Works are in full operation.

Plants of the American Sheet & Tin Plate Company at New Castle, Shenango, Farrell and Mercer are operating to practical capacity with 90 tin and eight sheet mills, while the Farrell plant of the American Steel & Wire Company is at about 75 per cent of capacity.

Wide Range of Equipment at Steel Show

Equipment and Products at Exhibition of American Society
for Steel Treating Widely Diversified

THE Steel Exhibition far surpassed the imagination of the most enthusiastic steel treater and in diversification and expanse has never been equaled. The attendance of members and guests exceeded any previous exhibition in the history of the organization, and taxed the capacity of Motor Square Garden to the utmost. Interest has increased with leaps and bounds, and without question, the Steel Exposition held in conjunction with the annual convention of the American Society for Steel Treating is destined to eclipse everything in its line.

matic control and oil burners comprised the exhibit of the George J. Hagan Company, Pittsburgh. Holcroft & Company, Detroit, had two small electric melting furnaces for operation on 110 volts, either alternating or direct current, while Hoksins Manufacturing Company, also of Detroit, had in operation a continuous electric heat treating furnace, in which the work, consisting of small parts, was put through 5 refractory tubes. Tate Jones & Company, Pittsburgh, exhibited a small electric hardening furnace with an automatic control unit. A model of a continuous rotating heat



Typical exhibits at the International Steel Exposition held in conjunction with the Steel Treaters Convention in Pittsburgh.

The floor space occupied by this year's exhibition was 50 per cent greater than the one held in Detroit last year, with about 35 per cent of those applying for space being turned down.

Numerous Furnace Exhibits.

Many electric and gas furnaces were shown in operation. A small muffle type heat treating furnace with temperature control apparatus, melting pots and laboratory temperature furnaces featured the exhibit of the Westinghouse Electric & Manufacturing Company. The General Electric Company, Schenectady, New York, showed a 5-kilowatt drawing furnace, a 13-kilowatt box type furnace and a 7.5-kilowatt semi-cylindrical furnace. An electric furnace with auto-

treating furnace as well as oil and gas burners comprised the exhibit of W. S. Rockwell & Company, New York.

A feature among the furnace exhibits was two gas fired tool heating furnaces, manufactured by the Combustion Utilities Corporation, New York, one with a recuperator together with an automatic control, while the other was operated without recuperation. A comparison of the efficiencies of the two furnaces was made by means of various meters. F. J. Ryan & Company, Philadelphia displayed a new type of oil and gas burner, automatic control and high temperature electric furnace resistors. Bellevue Industrial Furnace Company, Detroit, had in operation a complete vertical

muffle high speed steel furnace with temperature control, also a tilting aluminum furnace. A new gas fired high speed furnace with gas pre-heating chamber, oil and gas burners made up the display of the Dempsey Furnace Company, Jersey City, N. J. A two pot gas fired furnace using liquid heating media was a feature of the Chicago Flexible Shaft Company's exhibit. The Mahr Manufacturing Company, Minneapolis, operated an oil fired, over-fired heating furnace, a smoke model furnace and a motor driven blower unit.

Hauck Manufacturing Company, Brooklyn, N. Y., displayed a large variety of oil burners, low pressure oil burners, gasoline and kerosene torches, portable furnaces and high pressure oil tanks. Gas and oil burners and gas carburetors were to be seen at the booth of the Surface Combustion Company, N. Y. Combination oil and gas burners of high and low pressure types were demonstrated by N. C. Davison Gas Burner and Welding Company, Pittsburgh.

A demonstration of oxyacetylene cutting and welding and all types of accessories used in this work was featured by the Air Reduction Sales Company, New York. The Linde Air Products Company, New York, displayed welding and cutting apparatus for oxyacetylene and a number of cut and welded specimens. Electric butt welders of the flash-proof type with capacities up to 1½ inch rounds, spot welders and specimens of welds were displayed by the Federal Machine & Welder Company, Warren, Ohio.

The Pennsylvania Pump and Compressor Company, Easton, Pa., had in operation a direct driven compressor operated by a synchronous motor, and provided air pressure for neighboring exhibitors. The Spencer Turbine Company, Hartford, Conn., also had in operation several turbo-compressors supplying air for numerous gas fired furnaces.

Manufacturers of pyrometers, temperature control and recording apparatus were exceptionally well represented, many of them having their instruments in actual operation. Among those exhibiting were Leeds and Northrup Company, Philadelphia; Taylor Instrument Company, Rochester, N. Y.; Charles Engelhard, Inc., New York; Bachrach Industrial Instrument Company, Pittsburgh; Bristol Company, Waterbury, Conn.; Wilson-Maehlen Company, N. Y., and Brown Instrument Company, Philadelphia. Bausch & Lomb Optical Company, Rochester, N. Y.; E. Leitz, Inc., New York, and Scientific Materials Company, Pittsburgh, had on display equipment for metallographic study and preparation of specimens. The latter company in addition to exhibiting photomicrographic apparatus showed pyrometers and Brinell hardness testers. Impact testing apparatus and a Brinell hardness tester manufactured by the Pittsburgh Instrument and Machine Company, were on display. Steel City Testing Laboratories, Pittsburgh, Shore Instrument & Manufacturing Company, Jamaica, N. Y., and Tinius-Olsen Testing Machine Company, Philadelphia, Pa., exhibited quite extensively a varied assortment of testing machines.

Steel Manufacturers' Exhibit.

The increasing use of stainless and rustless steel brought out many of the manufacturers of this class of material and many applications of the materials were on display. A large variety of products manufactured from this grade of steel were exhibited by the American Stainless Steel Company, Pittsburgh;

Firth Sterling Steel Company, McKeesport, and the Ludlum Steel Company, Watervliet, New York. Tool and alloy steel products both in a semi-finished and finished state attracted considerable attention, and were displayed by Vanadium Alloy Steels Company, Latrobe, Pa.; Vulcan Crucible Steel Company, Aliquippa, Pa.; United Alloy Steel Company, Canton, Ohio; Atlas Steel Corporation, Dunkirk, N. Y.; Crucible Steel Company, Pittsburgh, and the Halcomb Steel Company, Syracuse, N. Y.

The Heppenstall Forge & Knife Company's exhibit in the form of an apparatus for testing the uniform sphericity of steel balls attracted considerable attention. The steel balls, after being forced up a small tube were permitted to drop from a runway upon a block of steel, rebound and pass through a ring about three feet above the block, then fall upon a second steel block set at an angle and deflected at right angles passing through an opening in a container also about three feet above the level of the block. Balls, defective as to sphericity, failed to make the loop. This Company also exhibited die blocks and forgings. The Kinite Company, Milwaukee had on display a number of interesting punches and dies used in the stamping industry which were cast to shape. For complicated shapes these dies eliminated much of the expense of the built up die, and have a wide application.

Carbonizing Boxes.

The General Alloys Company, Boston; the Swedish Crucible Steel Company, Detroit, and Driver-Harris Company, Harrison, N. J., displayed boxes, pots and retorts used for carburizing and annealing. Heat resisting alloys in the form of castings, bars, sheets and wire were featured by the Cutler Steel Company, and Ohio Steel Foundry Company, Springfield, Ohio. R. D. Nuttall Company, Pittsburgh showed a number of special hardened gears. Union Electric Steel Corporation, Carnegie, Pa., exhibited trimmer steel, piston rods and rams.

The Rodman Chemical company, Verona, Pa., had on display various compounds for use in hardening processes, luting preparations, quenching and tempering oils. The Case Hardening Service Company, Cleveland; E. F. Houghton & Company, Philadelphia; Park Chemical Company, Detroit, and the Roessler and Hasslacher Chemical Company, New York, also exhibited various hardening and quenching preparations. The Bellis Heat Treating Company, New Haven, Conn., demonstrated a heating medium for hardening and tempering of carbon, high speed and alloy steels.

An extensive exhibition of sand blasting equipment including barrels, cabinets and rotary tables were featured by the Pangborn Corp. Hagerstown, Md. The National Machinery Company, Tiffin, Ohio, displayed a number of samples of work produced on their forging machine, while the Henry Pels & Company, Inc., New York, exhibited photographs and blueprints of the work produced by its billet shearing equipment.

Foundry Fire Causes Big Damage

The foundry of the Hill & Griffith Company, Cincinnati, was destroyed by fire on May 11, causing a loss estimated at \$100,000. The belief is that the fire started from an overheated pipe of a facing machine. The fire, which threatened the plants of the Ansonia Copper & Iron Company, is the second experienced by the Hill & Griffith Company within the last month. The company's plant at 1246-1262 State Avenue, Cincinnati, was destroyed by fire of undetermined origin April 17 last.

The ELECTRIFIED FOUNDRY

THE thousands of visitors who attended the A. I. & S. E. E. convention at Buffalo witnessed an achievement. No other word expresses it. A complete foundry was assembled inside the convention hall, made ready for production in five days—and commercial steel castings shaken out of the molds and put under sand-blast 70 minutes after the current was turned on.

Authorities on foundry matters said it couldn't be done, just as conservative authorities on most things usually do—but it was done, and thousands of interested observers were treated to the unusual sight of foundry practice conducted under conditions, as clean, pleasant, comfortable and safe as in their offices.

The moving spirits in the enterprise were Mr. John F. Kelly, secretary of the association, and Mr. W. B. Wallis, president of the Pittsburgh Electric Furnace Corporation. From the inception of the idea their unremitting energy and unflagging optimism were invested. Not only was it necessary to "sell the idea" to other associated manufacturers—but a difficult assembly of engineering elements must be made in the limited space and more limited time.

All this was accomplished.

The American Radiator Company delegated Mr. Langworthy to operate the foundry. Twenty-four



MR. E. P. LANGWORTHY
Manager Arco Steel Plant American Radiator Co.

heats were melted, poured, shaken out and sand-blasted in four short days without mishap to workmen or to throngs of visitors who invaded the operation.

SCHEDULE OF HEATS

	Heat No.	Time of Heat	KWH/ton
9-15	1	70	625
	2	47	600
	3	45	500
	4	39	500
	5	46	500
	6		
9-26	1	65	625
	2	45	500
	3	34	500
	4	35	400
	5	47	500
	6	39	400
	7	40	500
	8	50	500
	9	48	400
9-27	1	70	750
	2	47	500
	3	45	400
	4	43	500
	5	40	400
	6	45	500
9-28	1	68	625
	2	56	500
	3	41	500



MR. W. B. WALLIS
President Pittsburgh Electric Furnace Corporation

TABLE I.

Elec. Furnace Consumption
Report and Heat Record
Form 515 SF

AMERICAN RADIATOR COMPANY
ARCO STEEL PLANT

Furnace No.	Melter	Sander	Grade	20-25c.	Mixture No.
Heat No. 12	Ladleman			Date	9-26-23 192—
CHARGE			REPAIRS		
Stock No.	Material	Metal Wgt.	Flux Wgt.		
1				Dolomite	Raw
2	Pig Iron			"	Burned
3	H. P. Scrap			Magnite	
4	Manganese Scrap			Magdolite	
5	Scrap			Kennedymag.	
6	Forgings	400		Magnesite	
7	"			Molasses	
8	Punchings	400		Glutrine	
9	"			Graphite	
10	Sand		20	Electrode Compound	
1	Scale			FireClay	
2	Iron Ore			Ganister	
3	Lime			Silica Cement	
4	Fluor Spar			Sleeves	
5	Carbo			Nozzles	
6	Cake			Stoppers	
7	Anhracite			Hot Tops	
8	Ferro Mang.	6		Sand	20
9	" Silicon	5		Pitch	
20	" " Mang. Al			Bricks	
1	" " "			Tar	
2	" " Aluminum				
3	" Chrome				
4	" Tungsten				
5	" Vanadium				
6	Nickel				
7	Aluminum				
8					
9					
30	Total	811			
1	TIME		A. M.	P. M.	REMARKS
2					
3	Time Current On			5:15	6 lbs. Manganese in ladle
4	" Slagged Off				
5	" Heat Tapped			5:56	5 lbs. Silicon in furnace
6					Heat test 50 seconds
7	READING OF METER				
8					
9	Start	After Tapping	K. W. H. Used	K. W. H. per Ton	
40	2,000	2,200	200	500	
1					
2	CONDITION OF FURNACE				
3					
4			Before	After	
5	Roof	12	Good	Good	
6	Bottom	12	"	"	
7	Banks	12	"	"	
8					
9					
50	Electrode Record		No.	Wgt.	
1	Electrode No. 1				
2	" " 2				
3	" " 3				
4	" " 4				
6	TOTAL				

All ferro-alloys were furnished by the Electro-Metallurgical Corporation of New York.

Electrification of the Foundry*

A Most Comprehensive Assembly of Essential Details Covering
a Complete Operating Unit

By LEONARD P. EGAN†

THE subject of electrification of the foundry is one that entails more than the mere selecting and installing of motors, controllers, wiring, etc., as is the case in the foundries today. It covers the maintenance of the entire plant equipment and its production of continued, uninterrupted service. It is inseparably linked with the design and application of all the equipment and the manner that it enters into foundry production.

This is accordingly not intended as an engineering discussion but rather as a discussion with the foundryman himself, of the possibilities of electrified methods and systems as applied to the process of molding, together with the reasons why, and not as an abstract problem in electrical engineering. In doing this, foundry jargon and parlance have been used to considerable extent and every effort has been made to steer away from engineering terms, a condition which

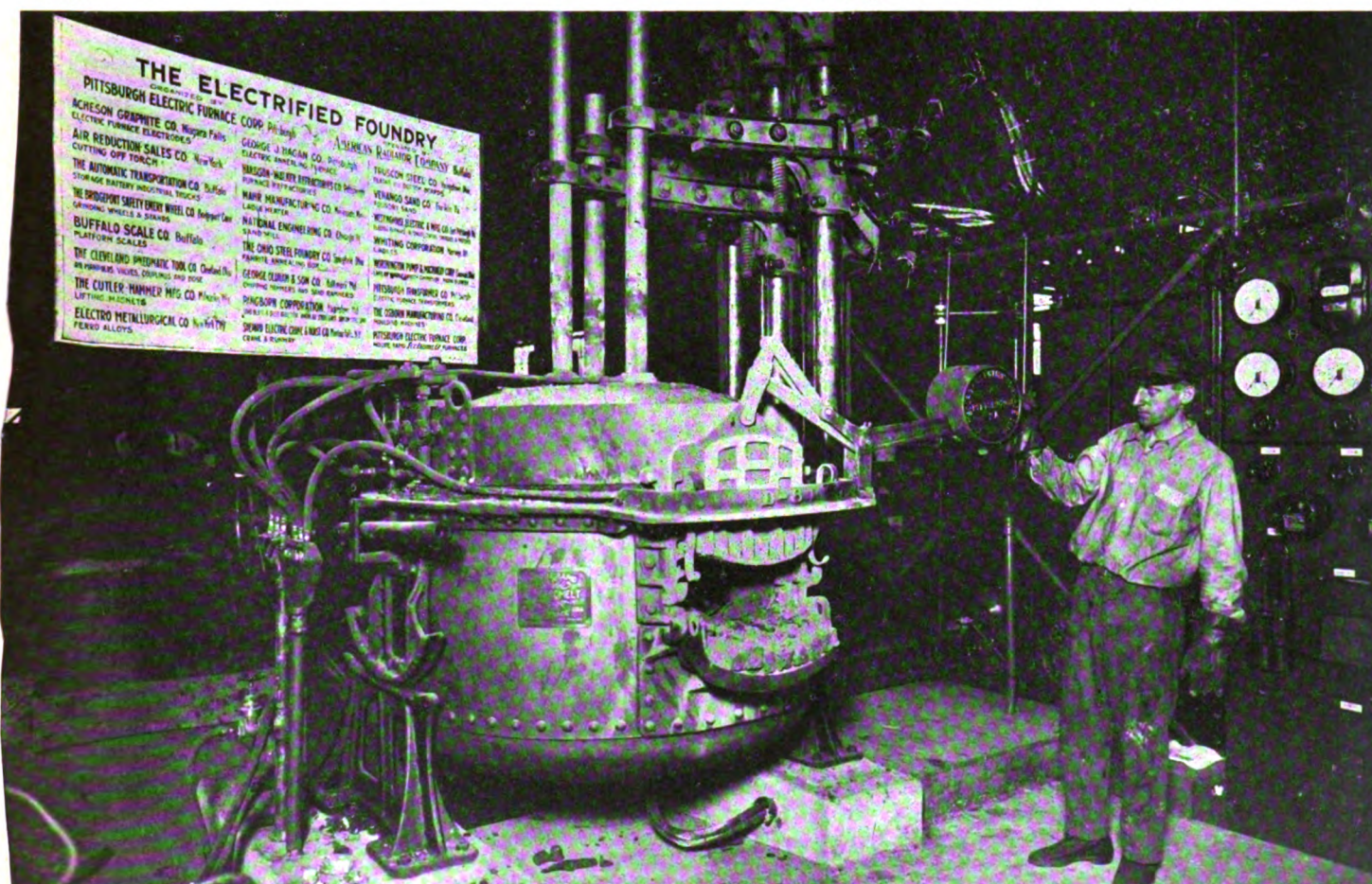
has been somewhat difficult and still have it cover the subject discussed.

We are endeavoring to show this whole problem from the producing and the operating man's standpoint, more than from the electrical man's, the considerations being mostly tonnage, improvement of production, reduction of the man hours per ton, both in productive and non-productive labor, the simplifying of the labor problem, the reduction of the various foundry operations to a more mechanical and stabilized basis, and to eliminate the great amount of laborious operations that exist in most of the foundries today.

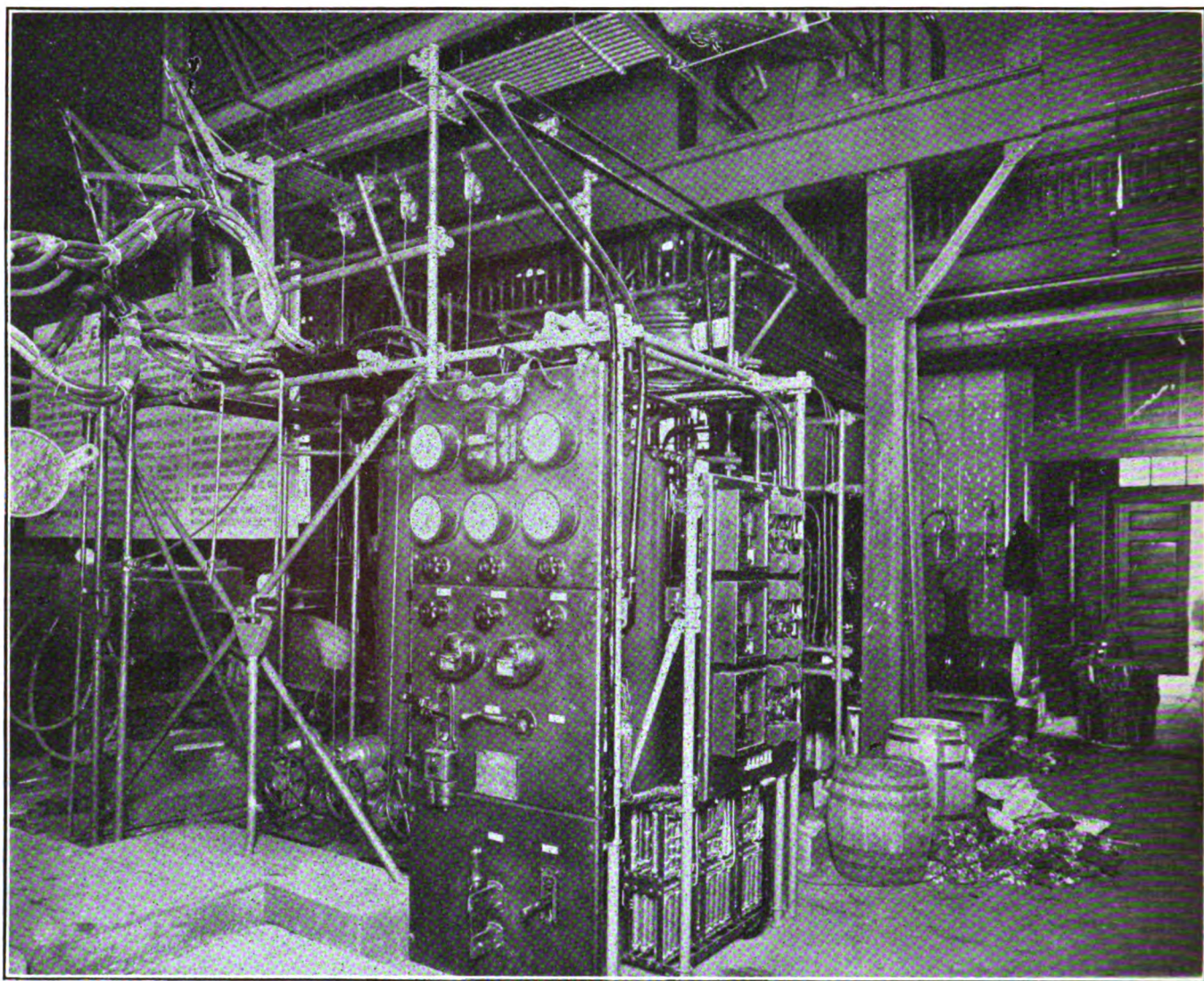
Date	Heats Made	Av. Time per Heat; Minutes	Av. Kwh. per Ton
Sept. 25, 1923.....	5	47.4	545
Sept. 26, 1923.....	9	44.8	481
Sept. 27, 1923.....	6	48.3	508
Sept. 28, 1923.....	3	55.0	541
Average		48.8	519

*Delivered at the annual convention of the American Association of Iron and Steel Electrical Engineers, Buffalo, N. Y., September 24-28.

†Special Engineer, Ohio Steel Foundry Company, Lima, Ohio.



This one-half ton per hour Lectromelt Furnace was in operation making steel castings in a model foundry at the convention of the Iron and Steel Electrical Engineers, Buffalo, N. Y., from September 25 to 28 inclusive with the above results. The electrodes, so essential to successful operation, were standard product of the Acheson Graphite Company. The refractories were furnished by the Harbison-Walker Refractories Company while the scale for weighing the scraps charged into the furnace by the Buffalo Scale Company.



A fine view of the Westinghouse control board. All electrical equipment in this foundry, except the Pittsburgh Transformer, was supplied by the Westinghouse Electric & Manufacturing Company

In this way the matter of production thrusts itself upon the electrical man. It will not be separated from the engineering and maintenance work, and for this reason the electrical engineer is in reality more vitally interested in the factors, methods and processes of production than he is in the purely electrical characteristics of the situation.

It would appear that all that was necessary to discuss this electrification of the foundry industry was a tabulation of the types of electrically operated machinery and equipment that existed.

The matter has become one of foundry practice; a foundry production problem rather than an electrical one, but like the electrification of the modern steel mill, the two are so intermingled and overlap to such an extent that the electrical man today is so vitally interested in production and how and why it is done, that he must be as familiar with the production of the plant as he is with the application and care of the equipment.

In fact it is this familiarity with and the knowledge of the production on the part of the electrical engineer and electrical superintendent in the steel mills, coupled with the great, broadening influence of this associa-

tion that has been the largest factor in the advancement of the electrical art in steel production today.

Today the steel mill electrical engineer has become a highly trained specialist. This has been brought about by his close study in the production of service by the equipment, by study in the proper application of each of its parts and units, based on the purely local conditions surrounding the past and its function in the whole scheme of steel manufacture.

It has been an uphill climb for the past 15 or 16 years and the standing of the steel mill electrical engineer today and the importance of his department is a far cry from that which existed when this association was organized.

Heretofore the foundry electrician or chief electrician who was invariably under the master mechanic, was an individual who kept the old electrical equipment in repair and installed what new equipment was required. Generally his influence in the shaping of the electrical development of the industry began and ended there, something of the nature of the electrical department of the steel mills 20 years ago.

The position he occupies in the scheme of foundry production today is about the same as that which

existed in the steel mills 20 years ago. The trend of things however would indicate that a change is about to take place which will require him to assert a more stabilizing influence in future foundry design.

The mere discussion of the subject before you today is significant in itself. It is in a sense a recognition by this body of specialists of the necessity for a higher degree of efficiency in an allied industry. It has heard the call.

It was originally intended to discuss the various types of electrical apparatus used in the foundry and to illustrate the situation with photographs. It soon became apparent that the paper would reach a prohibitive size and be reduced at last to a catalogue of foundry equipment. For this reason, it was decided to devote the paper to a discussion of the effect of electrification on the increase of production, the speeding up of the work and the stabilizing of the maintenance situation in general. The discussion has been divided into seven or eight general subjects:

1. Electric molding machines: Roll-oven, pattern draw machines, sand slingers.
2. Sand handling systems.
3. Electric furnaces: Melting furnaces for non-ferrous metal. Core ovens.
4. Cranes.
5. Purchased power.
7. Safety.
8. Air and electric hoists.

The question is so broad and offers such possibilities that to more than merely discuss here the underlying principle would be impossible. The subject could be divided into its various branches and a paper written on each. Such subjects as sand handling systems, molding machines, cranes, maintenance management, core baking ovens, etc., could be profitably devoted to individual and extended discussion.

Molding Machines.

There is great need in the foundry industry of reducing as far as is consistent, the making of a mold, to a predetermined mechanical operation, the sequence of which has been previously worked out and determined upon.

This should be developed to the highest degree obtainable in order that the production of the mold may be accomplished without dependance upon the personal skill and judgment of the workman.

Foundry work has been one that required a greater amount of shop kinks, skill and personal knowledge on the part of the workman than was found in other manufacturing practice.

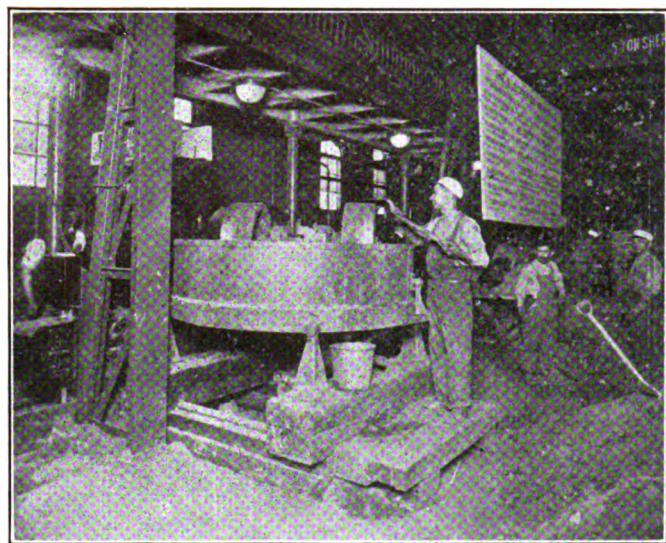
The casting when finished was dependent upon the skill and empirical knowledge of the molder. He was practically the arbiter of its fate. He took the sand, cut and blended it, shoveled, riddled or sifted it into the flask, rammed it up — usually by hand power — placed the gagers according to his judgment, separated the mold, drew the pattern, dressed and finished the mold, inserted the cores and closed the mold. In fact he produced the mold from the raw sand pile to the finished mold.

In this process he was required to perform all the operations of which at least 80 per cent were laborious, and non-skilled. He intermingled his empiri-

cal knowledge of founding in general with these laborious operations, and the number and quality of good, finished castings were a measure of the individual skill, knowledge and care of detail he gave, in reproducing uniformity in the mold.

Any one of a hundred factors in the application of the individual skill and empirical knowledge of the workman in the various stages of the production of the mold could cause a failure of the mold itself before pouring, or of the casting after being poured causing in either case loss of time, interference with the schedule of production, loss in money, and so on.

Adaption of mechanical molding by the use of molding machines reduces the greatest part of the mold production to a mere predetermined mechanical



Very efficient arrangements were made at the Electrified Foundry Exhibit to prepare the facing sand, core sand, and backing up sand. A No. 2 6-ft. diameter Simpson sand mill was employed for the purpose, machine being arranged with direct motor drive. By reason of the fact that most steel foundries recognize the necessity of mulling their backing up sand, a machine of the type used was in line with the modern idea of preparing heap sand the same as facing sand. If the backing or heap sand is treated in that manner it will tend to save on the facing sand, and to a great extent eliminate difficulties that are due to improperly prepared sand that has either too much or too little moisture, and using up more new sand than is otherwise necessary. The Simpson muller type of sand mixer permitted an accurate tempered backing sand, as well as using a low amount of new sand to keep up the proper bonded strength. The same mechanical efficiency is necessary for the preparation of facing and core sand used in foundries of this type. The molding sand used in the operation was furnished by the Venango Sand Company.

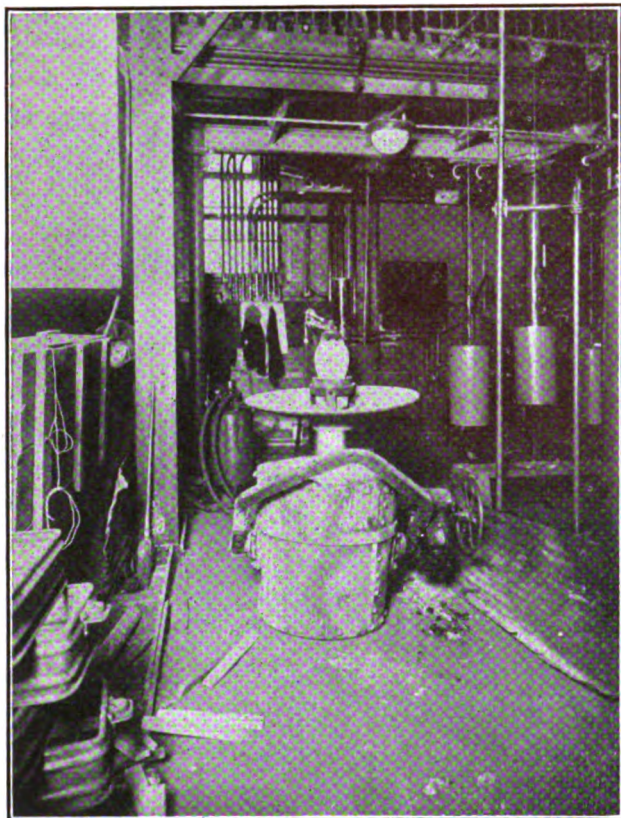
routine action. This permits the use of a cruder grade of labor in about 80 per cent of the operation and in conjunction with overhead bins and flash fillers it entirely eliminates the laborious work which was heretofore the heritage of the molder.

It is to eliminate these complex, human factors, together with the laborious work in the production of castings, that the molding machine finds its greatest field.

It reduces the production of molds to a standard practice up to the final smoothing and slicking of the mold and the placing of the cores. One skilled molder is thus enabled to finish eight or 10 times the number of molds that was done heretofore, permitting all other parts of the work to be done by non or semi-skilled help.

Molding machines are divided into about four general classes, squeezers, plain jolters, pattern stripping machines and roll-over-jolt-pattern-draw machines, all of which have been operated by compressed air heretofore.

Each type of machine has its own field of application from the squeezer mounted on wheels and rolled from place to place and used to a large extent in stove plate foundries and the production of small castings; to the direct-draw, roll-over jolt machines with pattern



Mahr Drier in Action over Whiting Ladle. The No. 74 ladle drier is primarily for use in gray iron foundries. For steel foundries the convex shield shown is replaced by one which is concave, lined with refractory material. Combustion takes place in patented double chamber nozzle, producing a steady, compact, and intense flame. Burner can be swung to either side to facilitate placing and removing of ladles and adjusted to any height on standard. Operates on compressed air, burning low grade fuel oil, distillate or kerosene. Position in shop is easily changed by removing the five bolts which fasten it securely to the floor. Dries linings quickly, evenly, and inexpensively.

draw, which are used for the production of heavy castings on both copes and drags where accurate drawing of the pattern is required.

The two outstanding features which might be called epochal, in the electrification of machine molding, which have been brought out in the last few years, are, first, the Roll-Over Jolt Pattern Draw Machine with electrically operated pattern draw and roll-over, equipped with electrically operated runout car, and second, the Sand-Slinger.

The Roll-Over Pattern Draw Machine is manufactured by the Osborn Manufacturing Company of Cleveland. It has been electrified in all of its opera-

tion except that of the jolt, which is still air operated. Some investigation has been made in the past for electrifying this portion of the machine, but to date no satisfactory substitute for the air cylinder jolt has been found. It seems that there is an instant reversal at the end of a stroke of the moving parts, including the mold on the table without rebound which is required for the packing of the sand and to allow for the escape of air by filtering out between the particles of sand. It would appear that the most logical method of producing this effect electrically would be to do it magnetically.

The electrification of the power operations of the machine renders them positive and uniform in their action and increases the speed of the machine to a degree not heretofore possible in the air operated machine.

This has been a pioneer movement in the electrification of the molding machine and while it has not been complete in all the movements of the machine, those that are operated electrically have shown such gratifying results, such savings in time and money, resulting from the improved service of the machine and the unprecedented speeding up of the molding operation, that study is being given to the electrification of the jolting mechanism of the machine.

Now that it has been demonstrated so conclusively that the electric molding machine is superior to the air operated one, it is only a question of time until other types of machines will be electrically operated.

The Osborn Electrically Operated, Direct Draw Roll Over Jolt Machine, with Electrically Operated Runout Car is made in various standard sizes to handle a flask up to 7 ft. by 12 ft. and can be arranged to handle larger flasks if required. It is claimed by the manufacturer that the electrically operated Roll-Over Direct Pattern Draw Jolt machine is of the unit construction, the machine being all self contained in one large, main frame, requiring no additional lining up on foundations such as required by other types of machines taking an individual foundation for the jolt and another for the Roll-Over. In drawing the pattern, the machine has a positive draw that is easily controlled from the very lowest speed to a rapid movement for completing the draw.

This not only increases the speed of operation, but it also eliminates the use of oil such as used in other types of machines. The high air pressure fed against the oil when exhausted, atomizes the oil, carrying it out with the exhaust. Also the gaskets must be fitted exceptionally tight and kept in perfect working condition to keep the oil from seeping out when under pressure, thus requiring the frequent addition of oil to the machine. It is self evident that these variable conditions existing in the air operated machine are absent when it is motor operated, and the movements, especially the nicety of the pattern draw may be repeated indefinitely with all the movements exactly the same in every detail.

The control that has been worked out for the drive is positive and simple. The roll-over and pattern draw movements are controlled at the end of their travel by limit switches which are adjustable. The motor operated run-out car onto which the mold is lowered before the pattern is drawn is controlled by push button. The length of travel is controlled by limit switches which are adjustable. One pressure of the button runs the car under the mold where it stops automatically, another

pressure of the button runs the car upon which the mold now rests, away from the machine where the mold can be handled by crane or hoist. This leaves the machine at once available for the next mold.

At an installation using this machine the manufacturer states that a speed of $3\frac{1}{2}$ minutes per mold, operating on the drag mold was averaged. This was considered remarkable as the flask carries $2\frac{1}{2}$ tons of sand in addition to its own weight and that of a heavy cast-iron pattern plate.

The Sand Slinger is a molding machine which employs a radically different principle in its operation than that of any other type in existing practice. The sand is pitched or thrown into the mold at a high velocity, which rams or packs it around the pattern.

Briefly, the machine consists of a spindle or revolving shaft with an electric motor direct connected at one end and an impeller head upon which a hard or cup shaped casting is attached; the impeller head rotating at motor speed, usually about 1,200 rpm. for iron castings and 1,800 rpm. for steel castings. At each revolution of the head a lump or slug of compressed sand is slung into the mold at a velocity of from 2,700 to 6,000 feet

per minute, and at the rate of 5 to 10 cubic feet per minute.

The operation is analogous to the old practice of the molders throwing hands full of compressed sand into the depressions and pockets of an irregular pattern. In fact this is the principle involved in the machine, except that the machine will throw up to 1,800 hands-full of sand a minute into the mold.

The machines are made in four types or arrangements; stationary, tractor, locomotive, and portable. Each of these types has its field of application in the foundry industry.

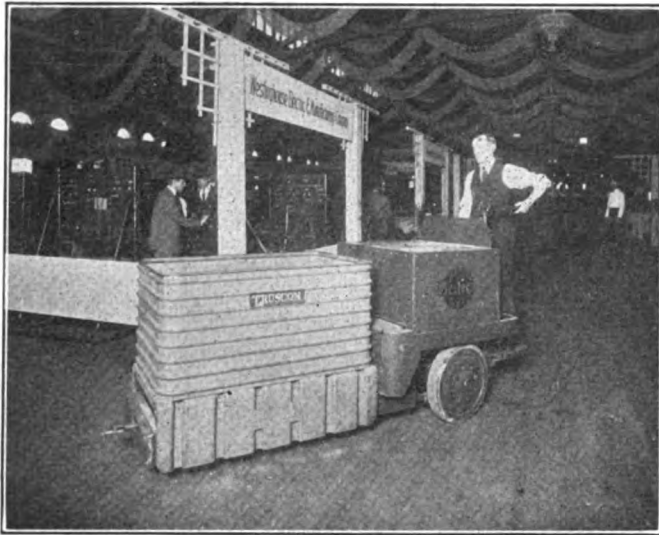
The stationary type is for use in foundries where a sand conveying system is in existence or other equipment arranged to supply sand to the machine. It may be used in conjunction with two stripping-plate machines and located between them. While a finished mold is being lifted from one machine, the pattern is being cleaned, and an empty flask put on the stripping-plate, the slinger is swung over and the other mold is rammed up. Another method is to mount several stripping-plate machines on a revolving table, each mold being rammed up as it passes un-



The Whiting ladle in the foreground with its perfect balance made hand manipulation easy for the small crew in attendance. Speed in pouring was absolutely necessary in order that the discharge of hot metal could keep pace with the fast working furnace. For handling the metal a five-ton Shepard Electric Crane was used. Molding machines were supplied by the Osborne Manufacturing Company.

der the head of the machine. In these arrangements the machine is kept running with very short intervals between the molds. With the stationary type of machine the main trouble—and that which has limited the daily production of the machine—is that of taking care of the movement of the flasks, molds and sand, all of which are in a congested neighborhood.

The tractor type is a combination of slinger, sand cutter and elevator, self contained in one machine and mounted on wheels. The machine tows cope and drag patterns either on carts or mounted on strippers. The molds and flasks may be handled with over-head



The use of Truscon pressed steel flasks was ideally demonstrated at this exposition. The figure shown above emphasizes the simplicity in transportation inherent in the nesting feature. Ease of handling, and speed of assembly were very evident. Just how old style foundry methods with clumsy flasks ever managed to exist seems a marvel.

cranes or by special crane towed by the machine which is the case in some existing installations. In one case the machine travelled in one direction one day and in the opposite direction the next day. This machine performs three molding operations. It lifts the sand from the floor, riddles it and rams it into the flask.

This type of slinger travels into the sand heap under power, collects the sand to a point directly under a bucket elevator where it is delivered to the screen of an oscillating riddle. A right and left hand sand cutting screw cuts and conveys the sand to the point directly under the bucket elevator. The riddle is so constructed that foreign matter, such as scrap, gagers, etc., will be deposited in a chute which conveys it into a scrap box mounted on the machine. The sand is conveyed by the oscillating riddle to a hopper mounted on the impeller arm and located above a belt which conveys the sand into the impeller head.

The portable type differs from the tractor type in that it is not mounted on wheels nor equipped with sand cutter screws. It must be carried from place to place in the shop and the sand must be delivered to it at the bucket elevator, where then all the rest of the operations of the tractor type slinger are repeated. Great flexibility is claimed by the manufacturer for this particular type of machine; it will ram any size mold and can be placed anywhere on the floor and

then moved to a new location at will. It can be used on pit jobs or on any flask; on long molds such as engine frames and so on, the machine can be used first on one end of the flask and then on the other.

The locomotive type of machine is for adaption for specialty or jobbing foundries where a number of castings are made from one pattern. The machine is mounted on wheels and travels on rails, having a track gauge of 9 ft. and moves under its own power. The machine is self contained similar to the tractor type and is equipped such that it is a complete sand preparation plant. It cuts and screens the sand which is placed between the rails, and delivering it to the slinger, after foreign matter has been taken out. It is claimed that the machine will also prepare any special facing sand. It will ram a mold 12 ft. wide, 7 ft. or less deep and any length required. It will also ram pit jobs approximately 6 ft. below floor level. In conjunction with these claims it is said the velocity of the sand leaving the ramming head at approximately 4,800 ft. per minute does not lose its velocity to a depth of 10 ft. All types of sand slingers are entirely electrically operated. The sand slingers are manufactured by the Beardsley-Piper Company of Chicago, Ill.

A great diversity of opinion exists as to the relative merits of the two radically different methods of machine molding. Claims and counter claims are made for each of the two methods and it is not the intention here to hazard an opinion as to which method has the brightest future, but in any event the two electrified systems are pioneer in their efforts and have possibilities that are far reaching in their scope. The sand slinger is not available at this time for use in a steel foundry in the United States.

Without doubt there are a number of types of castings that will continue to be made by hand, such as special castings in the nature of long engine frames, irregular ship castings, mill housings, loam work in large iron castings and so on. The average casting both steel and iron can be turned out by machines in quantity production and it is this type of work which should receive consideration.

One of the chief drawbacks to machine molding in the past has been the costly installation in air compression, air receivers and connected piping that was necessary to serve the machines when they were installed. The absence of the sufficient air compressor capacity has been one of the chief reasons against the more general use of machines in the foundry. This condition will be eliminated with the advent of electrically driven machines; practically no special apparatus will be required outside of the self contained machine itself. One of the chief aims of electrification is to reduce the air load to a minimum. The air system of the foundries, especially some of the larger ones are great wasters of power in the air lost through leaks. One installation in particular was noted when about 30 per cent of the total air compressed was required to furnish air for the leaks. Except for the sand blast, the portable air hammers and rammers and the jolt mechanism of the molding machines, the air compressor could be entirely eliminated.

Sand Handling System.

When the average foundry in operation today, was being layed out and built, the intensive manufactur-

ing program that is in existence today was not considered then. There was no conception of the scarcity or the price of labor that exists now, and aside from the cranes in the large foundries, few labor saving machines or handling equipment were in use. Now the necessity for well developed labor saving machines is being keenly felt and their adaption to the already accomplished foundry, its arrangement and practice becomes a serious problem to the average foundry power. Usually he is without competent and well seasoned engineering help to aid him in his need and prevent mistakes in judgment.

The methods of shaking out are crude in the extreme even today, except in one or two rare cases, the flasks are today shaken out the same as those in the earliest foundries.

The shakeout of the sand and its subsequent removal, reconditioning and return, for use again, is the bugbear of the average foundry. When the demand for a system where some of the laborious work could be handled other than by man power, a makeshift was usually provided. It was of wooden construction of timber and planks being bolted and spiked together. Generally it was of temporary construction. First one section was put up, then another part added, then a platform was nailed to the side, then a bin hooked to another side and so on.

A complete, well built and motor operated sand handling and conditioning system is needed in every foundry of any importance. The work entails a number of operations. The sand, after being shaken out of the flask must be collected; it must be screened and the foreign matter in the shape of scrap, nails, gags, etc., must be removed; new sand must be added to rejuvenate the old; the mixture must then be tempered, mixed and aerated; it must be left to rest for a short period in order to get a uniform moisture content, and finally the prepared sand must be returned to the molders.

There are a number of ways in which this arrangement can be carried out, which will vary in the general arrangement of each installation, but these operations must be performed in some manner. They differ in the degree of the mechanically collecting and returning of the reconditioned sand to the individual molder, without rehandling.

Certain standard units that go to make up the system are used. In a typical arrangement in service, the sand is conveyed by belt or other type of conveyor, from the floor; is passed through a priming screen for the removal of the larger foreign matter; is raised in an elevator to another screen for removal of other foreign matter; is passed over a magnetic separator; is passed through a tempering, aerating and cutting machine thence usually into a temporary storage bin. It then passes through a feeding cutter for continuously cutting the tempered sand and feeding it to overhead conveyors to individual overhead hoppers in front of the molders.

This system could be adapted to a number of different foundries where the outlay would be justified, using the same units, but under different arrangements.

There are other applications, especially in the smaller jobbing foundries, where a less elaborated and more self contained system has been worked out and which is now standard. The sand is carried to a

hopper on the handling system by bucket. It is then screened, cut, conditioned and returned to a storage hopper where it is distributed by bucket to the molding floor. This type of sand system forms a highly efficient unit in the jobbing foundry. The two sand handling systems are manufactured by the C. O. Bartlett & Snow Company of Cleveland, and are electrically operated throughout.

Another highly efficient electrically operated foundry unit is an Osborne Motor Operated, Flask Filler. Sand is stored in a bin from which it is delivered by elevator to the chute where it is fed into the mold.



The Cutler-Hammer exhibit was not limited to the lifting-magnet in the foundry. The figure above shows this feature booth at the exposition, where thousands of attractive sample boxes, filled with delicious sweets, were distributed free to visitors.

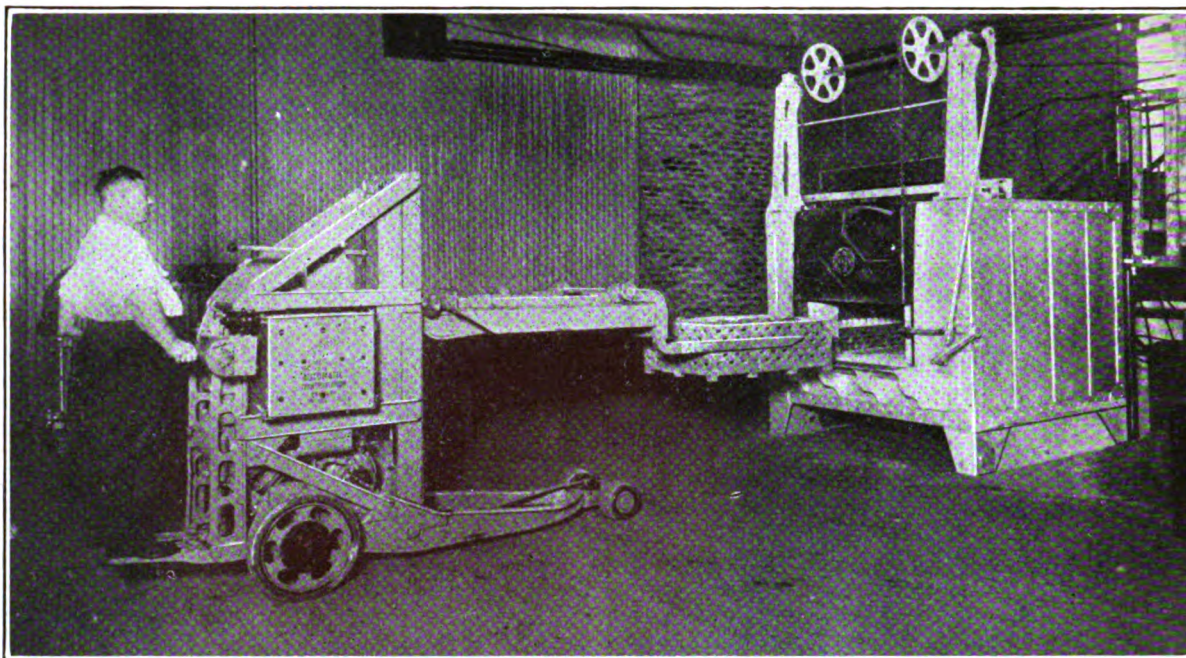
The machine is self contained and operated by an enclosed motor built into the machine. Except when the machine is elevating and discharging sand no part of the machine moves. This machine works well with the self-contained sand handling system. The flask filler is also used in conjunction with the electrically operated, rollover pattern draw molding machine.

Electric Furnaces.

The electric furnace is entering largely into the manufacture of castings by the steel melting furnace, the annealing and heat treating furnace and furnaces for the melting of non-ferrous metals—copper, brass, bronze, aluminum, zinc, etc. It is represented also by the low temperature oven for the baking of cores, a unit that is receiving more favorable consideration in foundry production, and is coming into more general use.

The subject of steel melting furnaces is being handled in another paper before this convention and is in most capable hands. No discussion is given to it here except to say that in the electrification of the industry, it has a very broad field of application in the jobbing foundry, especially where it can be run near to its capacity. However, in the larger steel foundries the open hearth furnace holds a very strong position and where large tonnages are handled, it will form the main process of melting for some time to come.

Electric annealing furnaces are also being handled capably in another paper before this convention and



The new "Automatic" Furnace Charging Truck as shown in the accompanying illustration, is a new departure in the field of mechanical handling equipment, and is meeting great favor in many foundries. Through its use all the handling of material operations from the feeding of raw material to the blast furnaces to the storing of finished products, are greatly facilitated. By means of its steel forks, tote boxes of castings are picked up by one man and quickly deposited or taken out of the annealing or heat treating furnaces, materially increasing the efficiency. The truck has a lifting capacity of 4,000 lbs. and is built in various lifting heights. The lift is by means of a single oversize screw revolving in a large bronze nut. The truck is equipped with two motors, one for propelling the truck and the other for elevating. The annealing furnace shown was supplied by the Geo. J. Hagan Company and the annealing boxes by the Ohio Steel Foundry Company.

no extended discussion of the subject is given here. The electric annealing and heat treating furnace has had a considerable development in the past five or six years, especially the treating furnace. It has a high degree of flexibility and where quantity production of a uniform type of casting is possible, it offers unlimited possibilities in heat treatment.

The use of this type of furnace gives complete control of the temperature, of the atmosphere, and of the manipulation. It permits an unlimited and sequential repetition of the treating cycle. It permits the unidirectional, continuous flow of the product through the furnace, entering at the cold end and leaving at the hot end. This permits the casting to be heated progressively over a uniform range, so desirable in heat treatment.

It eliminates the human factor to a high degree, thus placing the treatment of the product more in the hands of the metallurgist and less in the hands of the furnace attendant, and so on. In fact it is possible to completely heat treat castings, passing them through the hardening furnace, the quenching tank and the drawing furnace, holding the casting a uniform length of time in each furnace and in the quenching tank with a temperature in each casting that will not vary more than five degrees plus or minus. All this has been done commercially, the entire cycle being done automatically by pyrometric control and with an entire elimination of the human factor.

Under average foundry conditions the electric annealing furnace cannot compete with the combustion type of furnace in fuel costs but where the uniformity of the product or nicety of the treatment is involved,

the electric furnace has no equal. Heat treated castings have not heretofore been considered to any great extent but rather it has been largely a question of getting sufficient section in the casting. The near future however will see a reduction of the section and weight of castings with a corresponding increase in strength, necessitating heat treatment and there will be a field for the electric treating furnace there.

In the melting of non-ferrous metals such as copper, bronze, brass, aluminum, zinc and the multitude of special metals and alloys, including cupro-nickel metals, bearing metals, white metals, etc., the electric furnace is finding a broader application every day. In the opinion of the author, the development of the electric furnace in this field has been more significant and far-reaching in its effect than in any other branch of the art.

In entering this field it far outclasses the best production practice of any of the combustion furnaces in every factor, and from every standpoint except perhaps the first cost of the installation. It greatly simplifies the labor problem and renders the manager independent of the melter. It permits the routine, repetition of the melting schedule which has been reduced to the mere charging of the metal into the furnace, stirring and skimming it if necessary and when melted pouring it. The time and temperature of pouring is decided by pyrometer and can be placed under the eye of the manager or superintendent at all times. The judgment of the melter need have no place in the entire schedule.

It is conservative to say that the metal can be melted for half the cost of that of the combustion furnace

practice, considering the cost of fuel, metal loss, upkeep, etc., and this not considering the indirect savings in the improvement of the product, uniformity, reduction of rejections, satisfaction of the customers, savings in floor and storage space, absence of worry, and so on. The improvement in working and sanitary conditions in the foundry that are brought about by the use of the electric furnace are highly important items, there being an entire absence of noise, heat and fumes.

There are four principle types of electric furnaces used in this branch of melting: The open arc, the smothered arc, the resistance and the induction furnace.

The direct or open arc furnaces are represented by a number of makes and types such as the Snyder, Booth-Hall, the Volta, the Geollette, etc. The Geollette furnace, however, is in general use for brass melting by the arc process. The muffled arc furnace is represented by one type only, the General Electric. The resistance furnace is also represented by one type only, the Bailey. The induction furnace is represented by two types, the Ajax-Wyatt and the General Electric.

In this discussion we are considering only the four principal type furnaces that are what we would consider as applicable to the brass and aluminum foundry. They are the Rocking Arc Furnace, the Muffled Arc Furnace, the Resistance Furnace and the Induction Furnaces. The four types represent practically the entire field of commercial melting but they will be discussed from the non-ferrous angle. The vertical electrode furnaces of the steel melting type, such as the "Lectromelt", are discussed elsewhere.

The Rocking Arc furnace was developed by Dr. Geollette of the Bureau of Mines of Washington during the war. A patent was taken out on the furnace itself and later this patent was donated to the American public. This latter feature is covered in an article published in the Metallurgical and Chemical Engineering Magazine in 1919. In this way any one desiring to use the furnace may do so. The Rocking mechanism was developed by the General Electric Company. The furnace is manufactured by the Detroit Electric Furnace Company, of Detroit, Mich.

The furnace is a horizontal cylinder with a refractory lining and having a horizontal electrode passing through a round opening directly in the center of each of the cylinder ends. A hand wheel is provided for moving the electrodes in and out. An arc is formed in the center of the furnace, the heat of which is radiated to the walls and the bath. The furnace rests on a roller mechanism somewhat similar to that of the metal mixer in the steel plant. This mechanism rotates the furnace first in one direction, then reverses it and rotates it in the other. In this way heat is transmitted from the arc to the walls of the furnace and is in turn wiped off the wall by the metal as it passes over it. In addition, heat is radiated to the bath itself directly from the arc proper. The arc does not come in contact with the bath itself as in the steel melting furnaces and in reality it is of the indirect arc type.

The principle advantages claimed for this type of furnace are the low kilowatt hour consumption per ton of metal melted; the ability to melt all grades of scrap and turnings and the speed of melting. Without

doubt this furnace is the most rapid in its action and for heavy production has the largest capacity per unit of any of the four types mentioned.

Some of the disadvantages of this type of furnace are the proximity of a high temperature arc to the metal; the hand operation of the electrode; the necessity of pouring the heat when it is melted and the dependance of the furnace upon the Rocking mechanism and water cooling at the electrode ports. This furnace is made in large and small units as low as

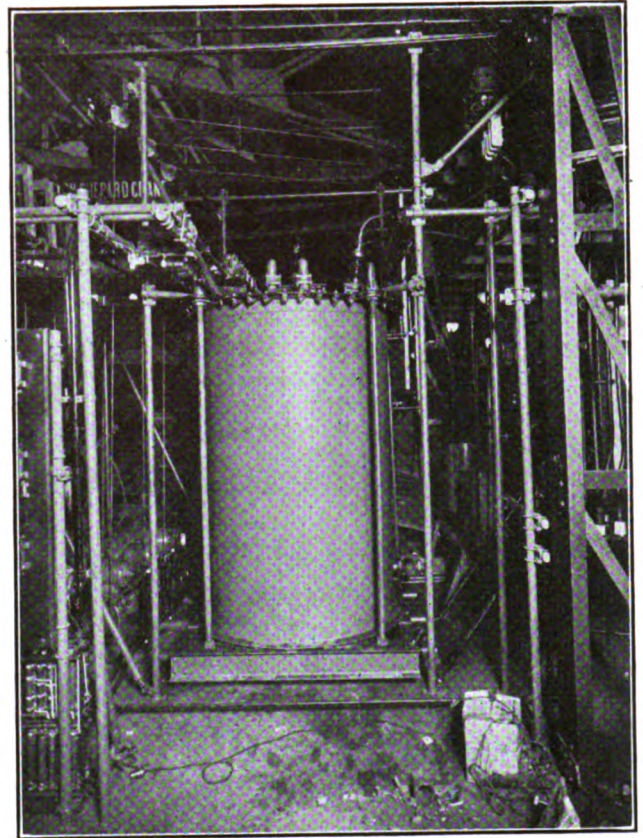


FIG. 11—Shows the transformer furnished by the Pittsburgh Transformer Company. Current was received at 2200 volts and delivered to the foundry equipment at 220 volts. The electrical equipment functioned perfectly, with the slight exception at the start. An error in wiring was traced back to the controller and quickly adjusted. When it is remembered that this foundry was not an experiment, nor an exposition "picture," but a real producing unit where steel castings were made for profits, it will be quickly comprehended how exceptional such construction performance was.

200 pound capacity, single phase. The current consumption is in the neighborhood of 200 to 225 kw. hrs. per ton. All of the metal may be poured, if desired, each heat.

The muffled arc furnace was developed by the General Electric Company during the war and at that time was made in the large size only, and was a combination of smothered arc and resistance type. Later on other types were made in smaller units having a hearth capacity of about 950 pounds and a melting rate of 500 pounds per hour. The furnace is two phase, arranged with a cross electrode embedded in the brick work of the hearth which connects with the two bottom electrode blocks. The return of the two-phase current supply is fastened to this cross electrode.

Heat is generated by the two short arcs drawn between the upper electrodes and the bottom electrode blocks; the arcs are smothered by crushed carbon which surrounds the arcs. The heat is transmitted to the metal by contact with the heated bottom, electrode blocks which are in direct contact with the bath, some heat is given off by radiation of the arcs and reflected by the roof. The furnace is equipped with electrode regulators, motor operated, is hand tilting and arranged for water-cooling of the electrode ports.

The kw. hr. consumption on daylight melting is 400 kw. hrs. per ton for yellow brass 60/40 and 470



The complete production of the Electrified Steel Foundry was cleaned perfectly in a standard Pangborn No. 2 (30/40) Type "GD-1" gravity feed barrel sand-blast using angular steel grit as abrasive. There was also installed and operating a complete standard Pangborn type "EH-1" hygienic cabinet-table sand-blast with 70-in. diameter rotative table for the cleaning of larger castings furnished by a local foundry. Both units were ventilated by a single exhaust-arrester unit; arrester being of the cloth screen type with direct motor vibrated screens. After passing through the arrester the purified air was discharged directly into the exposition building.

kw. hrs. per ton for red brass 80/20. The furnace has a rating of 120 kw. in transformer capacity. The hearth capacity is approximately 1,000 pounds with a melting capacity of 500 pounds per hour, the melting practice being to pour only 500 pounds of the hot metal, charging the same amount of cold metal into the unpoured remainder of the bath. The furnace operates at a power factor of approximately 95 per cent.

Some of the advantages claimed for the furnace are a large source of heat, at a comparatively low temperature; ability to measure and control the temperature of the metal; a neutral or reducing atmos-

phere; freedom from contaminating gases; freedom from agitation of the bath, allowing the dirt and slag to float to the surface where it can be skinned off, etc.

Some of the disadvantages are the proximity of an arc to the metal in the event the arc is not properly smothered; water-cooling of the electrode ports; trouble in holding the unpoured heat for long periods of time; amount of auxiliary equipment, etc.

The Bailey Resistance Furnace was developed by the Electric Furnace Company of Alliance, now of Salem, Ohio, somewhat earlier than either of the two preceding types. The furnace is made in different sizes, the one in most general use having a hearth capacity of 1,500 pounds, a melting rate of 500 to 800 pounds per hour and approximately 100 kw. in transformer capacity. Briefly it is a circular shell with a refractory lining, hand tilting and arranged so that the roof can be raised by a hand-wheel for renewing the resistor material. It is equipped with a trough of silicon carbide filled with crushed carbon which forms the resistor or heating element.

Heat is radiated by the carbon resistor to the roof and is reflected to the bath; some heat is also radiated from the sides of trough to the bath. The trough itself becomes conductive after being heated up and forms a part of the resistor, a portion of the current being carried by it. It is customary to pour the entire bath each heat, the time of which is about two hours. The cold stock is then charged into the furnace, stirred and skimmed if necessary, then poured.

The current consumption is approximately 300 kw. hrs. per ton and the metal loss under one per cent. The furnace requires no auxiliary apparatus or water-cooling. The furnace is single phase and operates at approximately unity power factor, the nature of the load being comparable to the same capacity of incandescent lighting load. Secondary taps are brought out from the secondary of the transformer, to points on a hand operated switch. The voltage is varied by moving the switch from point to point, thus controlling the electrical input and the temperature of the furnace.

Some of the advantages claimed for this type of furnace are uniformity of the metal by reason of the soft reflected heat; the temperature of the roof, the hottest part of the furnace, does not exceed that of the bath by more than 300 deg. F., the metal can be skimmed and stirred at will; the unpoured heat can be held indefinitely without disturbing the composition of the metal; a neutral or reducing atmosphere; absence of contamination from gases; complete control of the temperature and manipulations; flexibility of operation, low metal loss; absence of auxiliaries and moving parts, etc.

Some of the disadvantages are the roof must be raised and fresh carbon added to replace wastage; the possibility of breakage of the carbide trough, etc.

The Ajax-Wyatt Induction furnace was developed during the war, largely for the casting of cartridge case slabs of yellow brass. It is manufactured by the Ajax Metal Company of Philadelphia, the 60 cycle furnace in 80 kw. size having a hearth capacity of 1,500 pounds. The furnace is circular in shape and has a refractory lining that has been perforated and burned. This lining is made in a special shape and fits into the shell of the furnace. When the lining is to be renewed the old one is taken out and a new one

fitted in place. The operation is comparable to fitting a new crucible into a crucible type combustion furnace.

The circular chamber of the furnace contains the molten bath in one mass; immediately under the bath is the yoke of a single phase transformer, the secondary of which is a thin shell of metal being melted, constituting one turn around the transformer yoke. A large volume of current at a very low voltage is induced in the secondary or thin shell of metal at the bottom of the bath. The passage of this large current generates heat within the metal itself which is in turn transmitted to the bath above. The magnetic forces within the transformer set up a rotor effect of circulation of the metal which is constant as long as the current is flowing. This circulation is inherent in the induction furnace, and is not peculiar to this or any other type of induction furnace. The direction and intensity of the circulation is governed to some extent by the nature of the magnetic field set up by the transformer and also by the arrangement of the transformer.

As mentioned above the heat is generated at the bottom of the furnace at the bottom of the bath and carried to the bath by circulation. As the bath is in a mass and not in the form of a ring as in the typical steel melting furnace of this type, there is no "pinch effect" that was so troublesome in this type of furnace. The current flows around the secondary in the vertical plane instead of in the horizontal plane as in the steel melting furnace. The temperature is controlled by varying the voltage and the electrical input to the primary of the transformer. The furnace is either nose or trunion tilted; the nose tilted furnace is motor-operated while the trunion tilted furnace may be either hand or motor operated.

The furnace has a hearth capacity of 1,500 pounds and a melting capacity of about 500 pounds per hour. The current consumption is 200 kw. hrs. per ton and the metal loss under 1 per cent. It is single phase and has a transformer capacity of 80 kw. No figures are available as to the power factor but it in all probability is not better than 5 per cent.

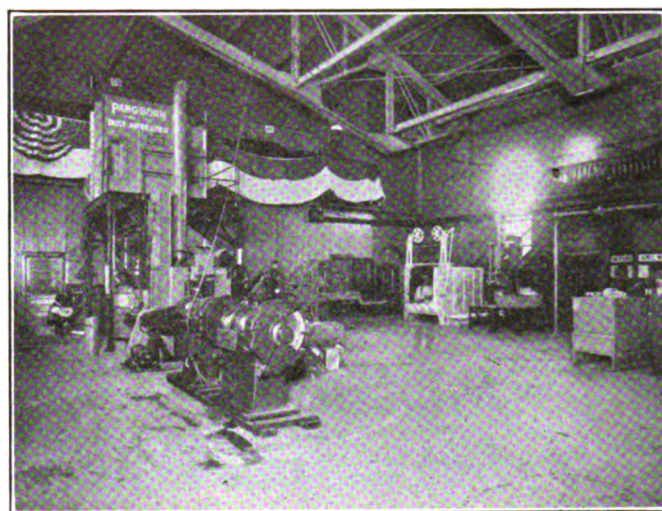
Hot metal from some external source must be charged into the furnace to prime it; when the heat is melted only a portion of it is poured, perhaps less than half of it. This same amount of cold metal is charged into the remaining bath and melted, when the operation is again repeated. During the night the unpoured portion of the last heat must be left in the furnace and the current left on to keep it in a molten state. If the last heat is poured entirely, hot metal from an external source must be charged in the morning. There must be hot metal to form a secondary before heat can be generated.

Some of the advantages claimed for this type of furnace are that the heat is generated within the metal itself; control of the temperature and manipulations; low power cost and metal loss; constant circulation of the metal insuring thorough mixing; absence of contamination from gases, etc.

Some of the disadvantages are necessity of priming the furnace with hot metal from an external source which limits its flexibility in foundry practice; special nature of the electrical application; cooling of the furnace primary coil; circulating currents in the melting of certain grades of metal, etc.

The General Electric Company's Repulsion Induction Furnace is a recent development just announced to the trade. It is built in one capacity only, arranged for nose or trunion tilting. The furnace has a hearth capacity of 1,200 pounds and a melting rate of 750 pounds per hour. It follows the same principles as that of the Ajax-Wyatt and is to some extent similar in construction, but differing somewhat in the manner of applying the transformer yoke to the furnace. It is arranged with a refractory lining of special shapes which have been perforated and burned. This lining of special shapes is fitted into the furnace as in the preceding case.

The circular chamber contains the bath in one mass and immediately under the bath and communicating with the circular chamber by two ports is a thin cylinder of molten metal surrounding the primary of the transformer and forming the secondary. This secondary, as in the preceding case, forms one turn in which a large volume of current at a very low voltage is induced. The passage of the current through the



This illustration shows the heavy duty motor driven grinders manufactured by the Bridgeport Safety Emery Wheel Company, Inc., Bridgeport, Connecticut, in use in the electrical foundry. Due to the sturdy construction of these grinders, with heavy bases and spindles of large diameter, the freedom from vibration was very noticeable. The spindles run in long ball bearing boxes, two sets to each box, the boxes themselves being bolted direct to the grinder base. This type of construction gives a set of ball bearings close to the wheels, also one on each side of the motor and prevents springing of the spindle. It also reduces the power consumption to a minimum and greatly lengthens the life of the machine since all wear comes on the balls and races, which can readily be renewed. The comments of many foundry superintendents indicated the enviable position which these machines hold in the trade due to their sterling qualities. They are made in various sizes to suit the particular needs and are fitted with modern safety devices.

metal of the secondary generates heat within it, which is in turn communicated to the bath above through the two ports which are located at the ends of the cylinder forming the secondary.

One of the chief differences between the two types of induction furnaces lies in the manner in which the metal forming the secondary circulates through and communicates the heat to the bath. In the General Electric furnace it passes up through a port at one end of the cylinder, thence through the bath and down through the other port at the other end of the cylinder,

In the Ajax-Wyatt furnace the bottom of the bath forms a sector of the secondary turn and the circulation is a churning action. In the General Electric furnace the isolation of the metal forming the secondary, from the bath, is more complete than in the other type.

With the ports under the bath located as they are, and by the primary coil arrangement, the circulation is longitudinal along the coils and unidirectional. Another chief difference in the two types is the ability to control the degree of circulation or agitation of the bath metal by shifting the position of the primary coil



FIG. 14—This series of Truscon pressed steel flasks, with the Shepard crane operator holding the ladle in correct position for rapid pouring is most interesting. The castings made (brake-shoes) were all small pieces weighing about 20 pounds in the rough, and required extremely rapid and accurate pouring to keep pace with a furnace producing nearly a half ton of hot steel every 50 minutes. The three moulders were college men from Booker T. Washington University, and they and the crane operator formed an exceptionally efficient crew.

on the transformer leg, thereby varying the field. This is a patented feature in this furnace, we understand.

As in the preceding case, hot metal must be charged from an external source in order to prime the furnace. In melting practice only a portion of the metal is poured each heat. In this case a little less than half of it is left in the furnace into which the cold stock is charged and when melted the process is repeated. During the night current must be kept on to hold the unpoured portion of the last heat molten or charge hot metal into the furnace in the morning.

The furnace has a transformer rating of 75 kw., is single phase, operates at 8 per cent to 75 per cent power factor, has a melting rate of 750 pounds per hour and a hearth capacity of 1,200 pounds. The current consumption is 200 kw. hrs. per ton for yellow brass, 60/40 and 230 kw. hrs. per ton for red brass 80/20. The metal loss melting yellow brass is one per cent and red brass .5 per cent. From the above figures it would seem that this furnace is more rapid in its action than in the preceding case and with the economies about the same. Low pressure air from an external source or a motor-driven blower auxiliary is required for cooling the primary coil of the transformer.

The advantages and disadvantages of this furnace are about the same as those in the preceding case, except that the rapidity of melting is somewhat higher.

Now as to the relative merits of the different types of melting briefly described, each of the types has a field of application and the discussion as to which is the best type for foundry application has been going on for a long time and will continue so as long as electric furnaces are manufactured and sold; it is a much mooted question. It is the opinion of the author that the field of application to the average foundry lies with the induction and the resistance furnaces.

Theoretically the induction is the ideal electro-thermic unit. All the heat is generated directly within the bath itself none of it being reflected or carried to the bath by any external medium. This is diametrically opposite to all other methods of melting; there is no electrode consumption, water cooling or electrode auxiliary equipment losses as in the arc furnaces; it can be constructed more compactly than other types of the same capacity and so on. In the melting of steel in the induction furnace two or three serious disadvantages presented themselves which practically have disqualified the use of this type of furnace as developed in late years.

One serious disadvantage was the inability to burn in a hearth or lining at a temperature higher than that of the bath itself. Another serious drawback was the disturbance to the power supply and the splashing and surging of the steel in the narrow channel forming the bath caused by the "pinch effect" which was inherent in the furnace. Another drawback was the necessity of charging hot metal in order to prime the furnace.

In the two types of induction furnaces just described, the first of these disadvantages has been taken care of by manufacturers in the same manner, that is by inserting a preformed and burned lining into the furnace. The second disadvantage is reduced to a minimum, if it exists at all, since the "pinch effect" phenomena is reduced by the weight of the bath itself. The third disadvantage remains however, and until it is eliminated the flexibility of this type of furnace and its field of application to the average foundry will be seriously hampered. The induction furnace has not proved a satisfactory unit in the commercial melting of aluminum which is a very tricky metal in the matter of pouring temperatures.

The resistance furnace inherently is sluggish in its action and no rapid changes in temperature take place in the furnace, thus forming a thermal fly-wheel effect in the routine operation of the furnace. However, the resistance furnace approaches nearest to the electrification of the combustion, melting processes with the elimination of a great number of the attending disadvantages, trials and troubles of the combustion practices. Anything that can be melted in the average combustion practice can be melted in the resistance furnace and can be done better and cheaper. It lends itself more than any other type to adaption to local shop conditions and its flexibility is such that it can be made to suit the average foundry conditions. It permits any degree of mechanical working of the bath, settling out of dirt and slag and allows a variation of manipulation of copper nickel alloys carrying zinc.

The neutrality of the atmosphere and the control of the temperature in both the induction and resistance furnaces make possible the holding of part of all of the unpoured metal for a long period without disturbing in any way the composition of the metal. This is a highly valuable feature lending itself greatly to the local conditions existing at any time in the production schedule or other shop conditions.

It cannot be denied that the furnace when installed, becomes a shop operating unit, and will receive only that care, attention and treatment which the operating man gives it and no more. If the furnace is to be a commercial success it must suit the operating department; it must permit of being adaptable to the particular foundry practice where it is to operate; it must be sufficiently flexible in its operation of being built around and worked into the local shop practice and methods, and still be sufficiently positive in its action to produce more and better metal at the pouring floor and do it cheaper than in the combustion practice.

Now the deciding factors or advantages in the use of one type of electric furnace over the other would be the net sum of the various advantages neutralized by the disadvantages. The economies in kw. hrs. per ton being an important factor, but not the most important. The deciding factors would be the uniformity of the castings produced; the ability to use low grade scraps without undue loss; the ability to melt any grade of metal under special process or procedure in local conditions with any degree of manipulation of the bath by rabbling, skimming, mixing, etc.; by placing the melting in the hands of the superintendent or metallurgist and taking it out of the hands of the melter, thus permitting the use of cruder labor and so on. The circulation of the metal as in the induction furnace is an advantage when the alloy is made up of new, clean metal; on the other hand it is very undesirable in melting dirty borings and small scrap, which is the case in a large portion of melting in the jobbing foundries.

There are two distinct fields of application in the two principles of electric furnace melting into which the two types fit. In mills and foundries producing large tonnages of the uniform composition, the induction furnace finds its best application, since it is rapid in its action, and probably the lowest in current consumption per ton of metal melted of any of the types in use. It is claimed for the Ajax-Wyatt furnace that it melts 95 per cent of all brass melted electrically. Over 50 per cent of all that melted in the brass rolling industry and more than that of all other types of electric furnaces combined. No special claims are made for the foundry industry.

In the average foundry where different alloys are melted and where the product consists of small and thin webbed castings, where intermittent operation may be required, where the heat may be made up of different grades of metal including wash metal and borings that are dirty, etc., the resistance furnace finds its best application.

One of the main obstacles to the application of the electric furnace to the foundry industry lies in its first cost. If a melting unit can be produced in small capacity, which will operate efficiently, and which can be sold for \$1,000 to \$1,500, then electrified melting will receive its greatest impetus. It is the

same as in the automobile industry. The greatest business in its history came when the "automobile" was reduced in price so that the every-day citizen could purchase one. It is no longer a luxury as in the past. That is what has been and is still the chief trouble with the electric furnace in the brass foundry. While being a necessity in fact, it is still a luxury to the average plant.

Core Ovens.

One of the most serious troubles met with in the foundries causing defective castings is the non-uniformity in the quality of the cores. An over-baked or burned core will crumble and hence alter the shape of the casting. An under-baked core will cause blow holes, porosity in the casting and small explosions in the mold, by production of gases arising from improper bonding of the core when a complete reaction has not taken place, leaving a portion of the bonding material and moisture for the evolution of gases.



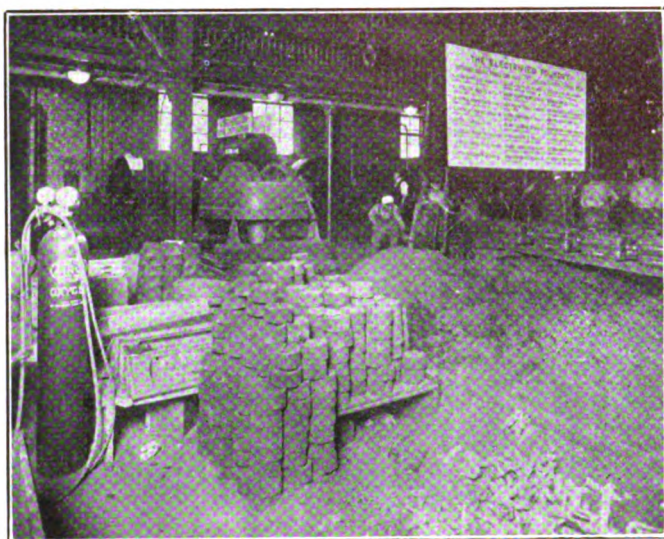
In addition to their demonstration of operating equipment, the Pangborn company carried on technical discussion at their spacious booth.

The necessity for a higher degree of uniformity in the cores is somewhat far-reaching in its effect and goes far beyond the mere rejection of the core itself from breakage or even beyond the production of the defective casting which must be rejected. It carries on into the cleaning room where the result of a poorly baked core is responsible for a great amount of the difficult, inside chipping of castings, with which the foundry superintendent is so familiar. It carries on into the sales department, as it is the salesman who must tax his resources in explaining to the dissatisfied customer what caused the poorly chipped and scabby casting, while he is endeavoring to secure the repeat order which he should reasonably expect to receive. In fact, the production of well baked cores of a uniform grade is one of the most important branches of foundry work and has received a vast amount of study in the past. A very small core may be the cause of the rejection of a very large casting.

The secondary or indirect savings resulting from uniformity of the core are considerable. If we can remove the prime cause of the trouble, which is the poorly baked core, the secondary effects are also removed. The troubles in the cleaning room are cor-

respondingly reduced, the man hours per ton of the product is reduced, the labor situation is simplified, the cost of production is reduced and the product is accordingly improved—which is perhaps the greatest advantage of all.

Cores are baked usually at a temperature of approximately 450 deg. F. Where the cores are irregular in shape with the thin walls and sharp edges, the necessity of closer regulation in the temperature of the oven becomes more apparent. This absence of regulation in a great many of the ovens in general use has been the cause of more defective cores than any other single cause. Generally the trouble is blamed on the binder, of which there are a multitude. Another serious trouble has been the absence of classification of the cores in the individual ovens. The larger cores require more time in baking than the smaller ones and where large and small cores are baked in the same oven, obviously we should not expect the same result in each. If the smaller cores are classified and baked separate from the larger cores,



A good view of the foundry floor, with the air-compressor in the background, of the Worthington Pump & Machinery Corp. Valves and fittings for the air line were installed by the Cleveland Pneumatic Tool Company; the chipping hammers and sand rammers were furnished by George Oldham & Sons Company, oxygen tank and torch by Air Reduction Sales Company.

under closer heat regulations, greater production at a much lower cost can be brought about. In a number of car type ovens of the pit-fired type the author has noted a temperature of over 2,000 deg. F. directly under the car, which is of course one that is not conducive to good core production, nor the lowering of maintenance costs.

The electrically heated core oven is coming into more general use every day, not only because of the vast improvement in the quality of the cores, but where the cores are irregular in shape, and of the smaller variety, it can be done cheaper and faster. The cost of attendance is greatly reduced in the electrically heated oven as compared with the fuel fired oven. The cost of maintenance is almost negligible since the temperature throughout the entire oven is uniform and is not much in excess of the baking temperature of the cores themselves. Combustion furnaces arranged with pit construction for coke, oil and coal involve frequent renewals and replacements.

The electric core oven may be of the car type, the rack type or the drawer type. The car type ovens usually are arranged in size about 5x8x10 ft., which lines up with a number of the ovens in the larger foundries. The heating elements or resistors are usually placed under the car, along the length of the floor and also along the length of each side wall three or four tiers high.

The roller drawer type of oven is perhaps the one that is best adaptable to the average foundry. It can be had in a number of different drawer arrangements and sizes to suit the local foundry conditions.

The manufacturers state that it is a highly efficient unit completely insulated throughout, and in conjunction with the automatic regulating panel a very close regulation can be made.

From the illustration it is evident that only a very small space is left open for the escape of heat and the effect produced on the temperature of the furnace interior would be negligible while a drawer is being emptied and charged.

The oven operating at temperature of 450 deg. F. would have a drop of not more than 50 deg. between the temperature of the resistor and that of the atmosphere, owing to the complete insulation of the oven. The oven is ventilated, the air being led in through the bottom and out through the top.

With the classification of cores possible in this type of oven, high speeds should be obtained, production speeded up and the cores baked at a considerably lower cost. With the control of the temperature that is possible and its uniformity throughout the entire oven, rejections should be reduced to a minimum and a core of uniform quality should be produced so far as the baking is concerned. In the drawer type oven the resistors or heating elements are located in the bottom drawer.

It is not to be construed from this discussion that the electric oven will be a cure for all core baking troubles; this is far from the condition that exists. It is possible to regulate the temperature and the electrical input which is the heat input to any desired condition and rate, and then to maintain this condition. It is possible to spoil the cores in an electrical oven as well as in the fuel fired one. One of the chief sources of opposition to electrically operated ovens and furnaces has resulted from the wild and extravagant claims made by the makers of the equipment, and from improper adaption in the particular cases.

There are a number of cores which can be baked in a fuel fired oven as well and more cheaply than in the electric oven, especially those which are very large and require only slow mass heating. A number of factors must be considered when deciding the question; saving in rejections; improvement in the quality of the core, hence in the casting; cost of power; cost of attendance; cost of upkeep, and so on. However, the future will see a marked increase in the installation of electrically heated ovens.

Cranes.

About the most important group of machines that goes to make up the equipment of the modern foundry and probably the most abused group is that of the electric overhead traveling cranes. The development of the modern heavy duty crane is probably one of the greatest factors in modern industrial development

and progress. It is becoming more important each year and is supplanting other handling, hoisting and heavy conveying methods.

The operating cycle on the floors place such dependence upon the crane that with a delay of a few minutes in the crane service the schedule and sequence of the floor operations are disarranged. Interruptions in the service are costly, both as to production and repair costs. It is possible for these repair costs to amount to sums that are prohibitive.

In the average foundry the cranes receive an enormous amount of abuse, the majority of which is unnecessary and all of it without any consideration of the effects produced. The use of a foot-brake is a rarity in a foundry; the author has viewed cranes in a foundry without foot-brakes, fuses or other current protection, and the hoists without either load brakes or arranged for dynamic braking. The cranes or their trolleys are used for dragging cars, buggies and flasks around the floors and from one place or building to another, all of it without consideration for the effect on the crane in general or the motors in particular. Usually the trolleys are equipped with a 3 to 5 hp. motor, instead of 15 hp., where this type of service is required.

The heavy duty crane is an evolution which is the result of the best efforts of a group of men directly engaged in the production of operating service of which the cranes form the principal part and by the issuance of specifications by the larger users of heavy duty cranes, the large steel plants.

If we have only a shop or industrial service to perform, then an ordinary industrial crane of the rated capacity and speeds taken from any one of a dozen or more catalogs of crane builders will serve, and with average attention would give continued service, but when the service is severe, as is the case on most of the molding floors, where the cranes are invariably stopped by plugging the bridge motor and where the crane and its trolley are used as a locomotive, a different set of conditions exists and a crane with the ability to operate day and night without interruptions must be used.

It must be heavily braced and should be of a wide span to keep it square and rigid. It should have large motors to withstand the enormous demand upon it by the quick starting, increased speeds and abusive plugging. It should have all the mechanical parts so arranged that replacements can be made in the shortest possible time and by crude workmen if necessary. The cycle of operations to which the crane will be subjected, this excessive rate of acceleration and deceleration, the abnormal plugging of the motors, all side pulls and dragging operations and the speeds required, should be carefully looked into.

In order to produce continued, uninterrupted service of the cranes, at a fair cost of maintenance, it is necessary to consider how repairs and replacements are to be made. A careful analysis should be made of all the arrangements so that the crane when operating on a substantial and well braced runway will be amply strong, be equipped with motors and controllers of sufficient capacity to handle the crane under all conditions and withstand the abuse, have the best safety and protection devices available, so that the crane will perform its cycle of operations.

All cranes and trolleys will work and give service; some work better than others and produce service with less care and attention, but all work and produce service with some degree of attention. It is this degree of attention that is required by the cranes that forms the chief difference between the various types. The manifestation of the difference between, say, a first class trolley and a third class trolley should not be that of a good mechanical condition in one case, and a loose, rattling, worn-out and delapidated condition in the other, but rather the difference should manifest itself in the additional time and expense necessary to keep a third class trolley in as good condition as a first class one.

One of the great difficulties met with in the adaptation of the traveling crane in the foundries is the absence of foresight that was given the matter when the original foundry was laid out. The average foundry building arrangement shows buildings, sheds, leans, tanks, bins and the like, placed haphazard and at all angles and all of it without due consideration for the ultimate handling of the raw material, the product under the process of manufacture or the finished product to be stored and shipped.

When the time of the "big tonnage" will have arrived, as it usually does, and the adaptation of more and heavier cranes is found necessary, it finds the runways and buildings with insufficient strength and weight to properly carry and support the number and type of cranes required for the intensive production program that has been built up.

The type, size and general layout of the original storage yard is of the greatest importance. It is generally the case that when the foundry is built, ample land is purchased for "expansion" (something connected with the remote future), but in the construction of the original plant, every conceivable effort is made by those concerned to concentrate the entire plant to as small a number of buildings covering the least space that can possibly be used.

Generally the storage yard, even in the larger foundries, consists of an area of ground with a boom derrick located in the center, which serves as a scrap yard and with open bins alongside a track for storage of sand, coke, coal, etc., where it can be unloaded by grab buckets. By far the greatest sufferer is the scrap yard of a steel foundry, the chief trouble being in the absence of an overhead crane or any provision for its installation in the future expansion program.

Where a scrap yard runway is provided it is usually of the typical single girder arrangement with no connection between the two girders, each being supported independently of the other. This was the usual runway in the steel mill stock yard a few years ago. The head room from ground level to crane rail in most cases was in the neighborhood of 25 feet. This head room limits for all time the piling height of the stock. The tendency of late years has been to build the runways higher and tie them together above the crane. In one installation noted, the runway columns were mounted on piers 7 ft. above ground level, the total head room from floor level to crane rail was 42 ft., or 17 ft. higher than in the old single girder construction. The advantages to be gained by this additional piling height are highly important. In any event, no other method of handling the scrap equals that of the overhead crane.

Purchased Power.

A foundry is intended solely for the purpose of manufacturing and selling castings. When it enters the field of the manufacture of power it takes over an enormous amount of troubles, worries and trials which attend this branch of manufacture, and in addition it is compelled to compete with a highly developed business in the conversion of heat into electrical power by the public service corporations.

On the part of the service corporation the economical conversion of coal or a liquid fuel into electrical power has been an intensive study with them for some years. They purchase their fuel at a favorable rate by reason of the quantity used, while the reclamation of waste heat by economizers, feed water heaters, etc., is carried to a high degree. Capacity loading of the generators is permitted, which then operates at maximum efficiency and so on.

For the small, inefficient power plant to attempt to compete with the service corporation of today is an extravagance on the part of the foundry owner. To even approach the cost of power as laid down by the service corporation at the foundry station requires the service of a very good bookkeeper with a political turn of mind. The last and only leg upon which the foundryman has left to stand is the claim that he has control over the service, that he has power when he needs it, and the possibility of an unpoured heat from an interruption of the service is eliminated.

In the last few years the dependability of the service furnished by the central station plants has so improved that the interruptions in service which occurred in the past are now becoming rarities. However, we would advise the foundryman contemplating a change from his own to purchased power, to carefully investigate the method of service in his individual case; to carefully look into what line or lines to which he is to be connected and to the degree of isolation of his individual plant with reference to the outer network of the central station's distribution system.

He should insist upon an emergency service from separate lines or feeders in addition to the regular service supplying his station under operating conditions, but preferably in the form of an idle cable between and connecting small groups of stations, being non-automatic and switched in by the plant or the service company, preferably the latter. These provisions should be carefully investigated and arranged for before a contract is signed. Then is the time to make the provision, not after the service is installed. He should not wait until a serious interruption in the service occurs and then use this interruption as an argument with the central station company for the installation of emergency service.

The advent of the automatic sub-station into the service field is another step towards the elimination of the isolated power plant. With the aid of automatic control, time delay and service restoring relays, it is possible to amply protect the system and restore service on any line or feeder without the aid of an attendant. The application of the automatic station in the foundry industry was discussed with the builders of the apparatus some time ago and the only drawback that appeared then was the necessity of attendance for the air compressors.

Since the compressor is invariably synchronous motor driven, the control could be similar to that of the synchronous motor driven M.G. set, except that

an unloading valve with an operating relay interlocked with the starting equipment would be required.

The station could then operate without attendance except for casual inspection.

Electric Welding.

The welding of castings occupies a very important position in their reclamation, chiefly by welding and plugging. A large amount of this work is still done by the gas process and there are a large number of acetylene gas generating plants in the foundry industry. There is no logical reason why gas welding should be used; it is possible to take a portable truck type electric welder to any location that a set of tanks can be taken, and aside from portability, no excuse exists for gas welding. For cutting, however, the gas torch is more applicable than the electric arc. It is possible to perform the same amount of welding by the arc process as by the gas torch at a great reduction in cost.

The process of electric welding is coming into more general use every day. We may expect to see the elimination of gas welding entirely in the foundries in the near future.

Briefly, electric welding is divided into two principal classes, metallic electrode welding and carbon or graphite welding. In the metallic electrode process, the negative electrode is made up of a metallic wire rod which serves the purpose of carrying the current to form the arc, and also to supply the necessary welding metal for building up the casting or part to be welded.

The metal is transferred from the end of the metallic electrode to the parent metal (which has been previously liquefied by the heat of the arc) in two or three different methods. By a spraying process, wherein small globules of metal are carried across the arc and deposited onto the parent metal; also by the forming of larger globules of steel on the end of the electrode which are carried to the liquid surface of the parent metal by the action of adhesion and cohesion, etc., and by some volatilization and condensation.

In the metallic electrode process a very short arc is maintained, ranging around $\frac{1}{8}$ in. to $\frac{3}{16}$ in. The condition and appearance of the weld being governed largely by the ability to hold a uniform arc, which is one of the chief qualifications of a good welding operator. With the metallic electrode process, the metal generally is more uniform and the welds are stronger and have a smoother and more uniform surface and if the short arc is maintained there is almost entire absence of oxidation of the metal.

Welds from metallic electrode are made where ductility and strength are required. The greatest majority of electric welding is done with this process since a more perfect fusion and union of metal is formed by this transfer from the end of the electrode. Where parts of castings, machines, frames, gears, etc., must be machined after welding up the metal at the faulty point, this method of welding is largely used.

In the carbon or graphite electrode process an arc is drawn by the carbon (which forms the negative electrode) and the metal for plugging or filling is furnished by a filler or welding rod fed into the arc from the side. Where large quantities of metal must be deposited in a short time, the carbon process is invariably used. Larger volumes of current may be handled and accordingly there are large quantities of

metal deposited in a shorter space of time. In this way larger amounts of metal may be deposited and the process forced for filling in large holes by using larger volumes of current, which are limited by the capacity of the machine and the weld to be made.

In the carbon electrode process currents range from about 15 amperes to about 400 amperes. In special cases this has been run as high as 600 to 800 amperes, especially where high speeds are required. In the metallic electrode process current ranges from 15 amperes to 225 amperes, approximately. With metallic electrode, about three or four different size welding rods are used, depending upon the volume of current, they range in size from 1/16 in. to 3/16 in.

There are a number of types and sizes of welding apparatus on the market for both alternating and direct current welding. The foundryman should be familiar with the various types and makes, since they are used to a greater extent in the foundries than other branches of manufacturing. For every day foundry use the direct current welder arranged for either carbon or metallic electrode work is the most flexible.

Safety.

While the application of electricity to the industry has been considered in the past as highly dangerous and has to some extent influenced the cost of accident insurance, to the electrical man, as compared with those in competitive lines, it is now a well known fact that accidents which result directly from electric shocks or burns are small as compared to those which result from the mechanical equipment. The overhead crane has been a most serious offender in this respect, and is responsible for more accidents in the steel industry than from any other one branch of the equipment.

It has been the author's misfortune to be sent to the hospital under hurried conditions on more than one occasion, and in every case it has been the result of accidents while on overhead handling machinery.

Air and Electric Hoists.

Air cylinder hoists are used to a large extent in the foundry industry, chiefly in conjunction with hand moved jib cranes. They are wasteful users of power by reason of the leakage of air around the valves and piston rods and in the connected piping. There is no logical reason why these hoists should be operated by compressed air, in fact, even neglecting the leakage, the relative cost of power between the electric hoist and the air hoist is such that the electric hoist will operate at less than half the power cost of the air hoist.

In a discussion of the relative merits of the two types of hoist with the representative of one of the large manufacturers of electric hoists, the following figures were submitted to show the amount of power used by an air cylinder hoist and an electric hoist.

For purposes of comparison take a 1-ton hoist making 100 capacity lifts per day; 6-ft. lift; direct current.

Electric—

It will require 8 amperes to hoist 2,000 lbs. at 24 ft. per minute or 1760 watts.

It will require 2 amperes to lower 2,000 lbs. at 60 ft. per minute or 440 watts.

Time required to hoist 2,000 lbs. through 6 ft.—6 divided by 24—or 1/4 minute or .0042 hour.

Time required to lower 2,000 lbs. through 6 ft.—6 divided by 60—or 0.1 minute or .0017 hour.

Current consumed:

Hoisting $1760 \times .0042$ or 7.39 watt hours.

Lowering $440 \times .0017$ or .75 watt hours.

Total to handle load 8.14 watt hours.

100 loads— 100×8.14 or 814 watt hrs. per day.

Or .814 kwh. per day or 244.2 kwh. for 300 days.

Air—

We will consider the cylinder type (unbal.) which takes the least air of any. Consider 80 lbs. per sq. in. against the piston, which means 100 lbs. at receiver.

At 80 lbs. pressure, a piston area of 35 sq. in. is required.



Cutler-Hammer exhibit at Buffalo Foundry Show — The Cutler-Hammer Manufacturing Company had on display in their booth a dismantled "Red" magnet of the same size and construction as the magnet seen in operation at the Electrified Foundry Show. This was the first time a dismantled magnet had been exhibited and attracted the interest of the engineers having Cutler-Hammer magnets in service under their supervision. The strap copper, steel bobbin coil with its high space efficiency and the flanged steel outer pole shoe were features particularly emphasized. The shape of the "Red" magnet outer pole is designed to protect the shoe against breakage or loosening. The pole shoe can be easily renewed when it is worn down after several years of service. The magnet controller, with its husky switches and grid resistor, was also featured.

For each lift of 6 ft., 2,500 cu. in. of air at 100 lbs. receiver pressure and 80 lbs. piston pressure will be required.

Or a total of 1.46 cu. ft. of compressed air or 9.40 cu. ft. of free air will be consumed.

It is rarely that the power used in compressing air to 100 lbs. pressure will fall below 1 hp. for each 4½ cu. ft. of free air compressed per minute.

Hence, in compressing 9.40 cu. ft. of free air to 100 lbs. gauge pressure 2.09 hp. will be consumed for one minute.

Converting this to its corresponding electrical unit for comparison with the electric hoist, and also because the compressor is more economical when driven electrically.

2.09 hp. will require 1660 watts of electric current for one minute or 27.7 watt hours per lift.

Total to handle each load 27.7 watt hours or 2.77 kwh. or 831 kwh. for 300 days.

The motor air hoist will consume about three times as much power as the piston hoist. Now take into consideration the numerous direct and indirect and unavoidable losses involved, distribution and maintenance of an air system and the use of air for hoisting purposes becomes an extravagance.

The trouble with the adaption of the electric hoist in the past has been the inability of the hoist to withstand the abuse received. With the advent of a more rugged type, the electric hoist will supplant the air hoist now in general use.

In general, the apparatus that goes to make up the equipment of a foundry should be of the most rugged type and be amply braced. It should be well anchored and have heavy foundations, and all structural and plate fabrications should have heavy sections, to withstand the vibration and general wear and tear that results from the enormous abuse that foundry equipment receives. All cranes should be overmotored above that which is in general use in industrial cranes.

In conclusion, the advancement towards the complete stable and dependable electrification in the foundries that now exists in the steel mills will not receive the corresponding impetus as that of the steel mill until the foundry managements recognize the necessity of giving a higher standing to the electrical man. They must give him a higher authority, allow a broader scope in his efforts, more consideration for his opinions and recommendations in the development of the industry. On the other hand, they should demand of him a broader knowledge of industrial-elect-

trical applications and maintenance management in general. He must assume a more definite and stronger position in the application and the development of the equipment. He cannot longer be considered as a "trouble shooter" and a "wire fixer." He is a most vital factor in the production of service by each and by all units of the equipment. As the equipment is intended exclusively to produce and furnish service, continuously and without interruption, without breakdowns if possible and all of it at a minimum of maintenance cost, the degree of service that the equipment produces under operating conditions is intimately intermingled with his routine duties.

Most important to successful electric furnace operations are the transformer functions, an efficient and uniform flux distribution in the several phases, and a symmetrical and balanced inter-phase relation.

The double magnetic circuit core and elliptical coil design, which have proven so satisfactory in Pittsburgh single phase transformers, is carried forward into the water-cooled Pittsburgh polyphase transformers.

In Pittsburgh polyphase transformers, three vertical cores, upon which the respective coils are mounted, are connected by horizontal and outside vertical yokes so that each coil at all times is linked with a divided magnetic circuit having minimum magnetic resistance and correct interphase relations. The magnetism of the middle coil threads through the cores of the other two coils, and that of each of the outside coils through the core of the middle coil and the nearest outside vertical yoke.

A distinctive feature of this Pittsburgh polyphase furnace transformer is that it can be operated open delta.



Arc welding and cutting, so important in modern foundry practice, were adequately cared for, at this exposition foundry, by this complete Westinghouse Arc Welding equipment. Every precaution to reduce hazard is evidenced by the screen—ornamental in this case—which protected the operation.

THE SAFETY CRUSADE

Industrial Welfare Work With Particular Relation to Housing

Industrial Welfare a Subject of Great Importance at the Coal Mine—Description of a Recently Constructed Model Mining Town in Virginia

By G. H. PROSSER*

WELFARE work as a composite term may well be used to express in general the sum of all contact between the industrial worker and his employer during the leisure hours of the former and overlapping to a large extent into the hours of active employment, particularly with relation to such subdivisions of the subject as accident prevention and sanitation.

Inspired by economic as well as humanitarian considerations; stimulated by the immediate and beneficent results of early trials and fostered by state and national governmental departments the subject has assumed an importance undreamed of a quarter century ago and the application of its principles; more generally recognized, year by year, has now advanced to an importance surpassed only by the major considerations of production costs and sales policies.

The nightmare of all production managers, labor turnover! The chief aim of every plant employment

office, the substitution of the reliable steady worker for the incompetent and will o' the wisp floater! These, and related subjects have, with increasing frequency, engaged the full attention of executive minds and the crystallized results are in evidence in and about every industrial plant of importance and only proportionately less in minor operations.

Some idea of the importance of welfare work to our industries and the extent of its present application can be gained by a glance over the following tabulation with the thought well in mind that this is a base outline, since each of the subjects mentioned is capable of much subdivision:

Safety—Posters and placards; lectures; machinery and safety appliances.

Health—First aid work; medical service; emergency and general hospitals; dental clinics; visiting nurses, child care and feeding; workmen's bathhouses; company restaurants.

*Chief Engineer, Nicola Building Company, Pittsburgh, Pa.



FIG. 1—Upper part of the village of Derby, located on Preacher's Creek in Wise County, Virginia. The Derby Mine of the Stonega Coke and Coal Company is being opened at this point, and when complete will be one of the most modern and best equipped in the region. The tippie may be seen in the background.

Sanitation—Sewers; sewage disposal; garbage disposal; sanitary plumbing; water supply.

Education — Public schools; Americanization; manual training; gardening.

Amusements—Clubs; gymnasiums; bath pools; motion pictures; play grounds.

Financial — Stock subscription profit-sharing plans; pensions.

Housing—Last on the list, but one of the first in importance.

There is scarcely any subject of general interest and equal importance which has received the attention given in the past few years to the problems of proper housing. The laxity and indifference of the recent past has entirely disappeared and has been replaced by the greatest attention and intelligent interest on the part of prospective tenants as well as of those charged with the responsibility of planning and construction.

The requirements of the better class individual workman and his family and their appreciation of advantages, practical and esthetic, provided for their comfort and convenience have become so apparent that the industrial operator has but one alternative: to meet the demand or be content with the offal of the labor market. All thought of direct profit on the real estate and improvements must be forgotten or rather charged to the account of reduced operating expenses resulting from lower labor turnover and increased production.

A notable example of intelligent planning and the application of modern ideas is the village of Derby on Preachers Creek in Wise County, Va., now under construction for the Stonega Coke & Coal Company, a subsidiary of the Wentz Company of Philadelphia.

This operation is of special interest in that it involves the construction of a complete community unit,—store and office building, theater and amusement building,

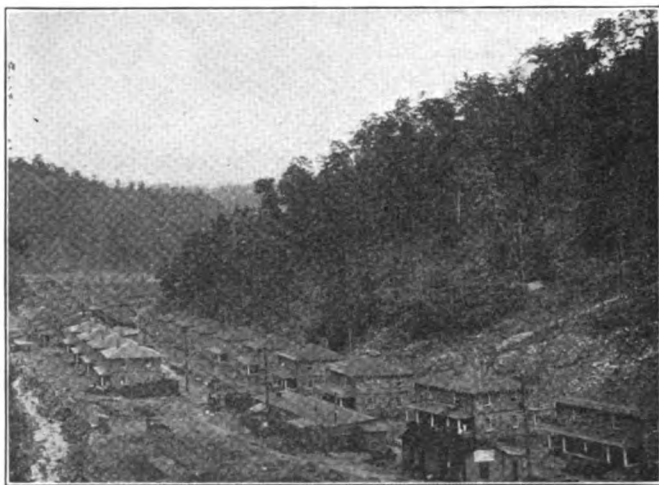


FIG. 2—Another view of the village, with construction not yet completed. Improvements will include paved roadways and sidewalks, fences, street lighting and shade trees. In common with other districts of Virginia and West Virginia, the surface contour does not lend itself readily to town building, the narrow valleys restricting operations. In this case it was necessary to relocate the stream shown at the left.

hotel, schools, church, miners' bathhouse, superintendents residence, doctor's residence, cottages for subordinate bosses and foremen; 90 double houses for miners, all of which have five rooms for each family and 70 having four-room apartments; also motor barn and shop,

sub-station, community garages, offices for mine foreman and assistants, storage buildings for explosives and supplies, etc.

The exterior walls of all buildings are constructed of 5 x 8 x 12 two-cell shale tile, veneered with brick on the store and office building and church. All buildings are of substantial and pleasing design; the hip style of roof



FIG. 3—This illustration shows a typical miner's house. These buildings are of tile construction, with doors and partitions of wood frame construction. They are plastered throughout, electrically lighted, and piped for running water.

generally prevailing. All foundations are of concrete, and the building generally, in conformity with the practice in the district, are built without cellars, except as are required for the accommodation of heating plants.

Floors, partitions and roofs are of wood frame construction, except in some few cases where structural steel and reinforced concrete are indicated to provide for concentrated floor loads.

All buildings except plant structures, are plastered throughout. Official houses and public buildings have heating plants located in basements, and all buildings in the town are electrically lighted throughout.

The town has an adequate supply of pure mountain water with connection to each building and to numerous fire hydrants conveniently located. Each workman's apartment is equipped with a kitchen sink and toilet located in tile enclosure on the rear porch with door which opens on the porch. The water closets are of automatic flushing non-freezing type. All official houses and public buildings have plumbing equipment which is modern and complete in all respects.

Sewage disposal is provided for by group units of septic tanks placed entirely underground and connected with each house sewer, it having been decided that a more uniform flow and consequently a more satisfactory operation of the system is thus obtained than when separate tanks are used for each building. The effluent from tank units is carried into the soil through nitrification beds of porous farm tile laid in boiler cinders.

Porches of all dwellings are of masonry construction of concrete floors and steps to yard level.

In fact, the entire scheme of the buildings has been based on the best principles of real economy, with due regard for the true relation of first cost to maintenance charges and insurance rates.

CURRENT TECHNICAL DIGEST

Electric Core Baking

One of the most perplexing problems of the metal casting industry is the baking of a satisfactory core, for an improperly baked core means defective castings with a direct loss which is greatly out of proportion with the actual cost of the core itself. Therefore the metal casting industry has been ever on the alert to improve core baking practice in order that the rejection percentage, which many times spells the question of either failure or success, should be reduced.

The electric core oven has met with more favorable reception than has probably any other method of core baking for the following reasons:

- (1) Because a more perfect core can be produced with its use.
- (2) Because in many lines of work electric baking with a reasonable power cost shows a decided overall saving.

There is no contradiction in the fact that the basic cost of electric heat is on the average greater than either that developed through the use of oil, coal or gas where those fuels are obtainable at average cost. However, upon investigation it can be quickly seen that the heating efficiency of an electric core oven is vastly different from fuel heated ovens. So while on superficial examination the fuel type of oven as expressed in the use of coal, oil or gas may appear cheaper, actually on comparative test in innumerable classes of industrial power rate (between 1c and 2c per kwh.) shows a definite saving.

To clearly indicate this point we will consider actual figures in heat value and oven efficiencies.

It will be readily admitted in the most conservative quarters that an electric oven may be built with a heating efficiency of from 80 to 90 per cent. This efficiency is the result of definite control of heat within a very close range of the treating temperatures, both as to temperature and capacity or volume desired during the process; whereas with other types of fuel as mentioned the delivery has to be continuous with an exhaust of spent gases unless wide fluctuations are to result in the temperatures within the heating medium.

One kilowatt hour, which is the basis upon which all electric power is sold, has a heating equivalent in Btu. of 3417. Practical tests have shown that the electric core oven will bake averages as high as 18 lbs. of cores per kwh. consumed, but conservative practice can be considered at 16 lbs. Therefore we may consider that for an expenditure of one kwh., 16 lbs. of satisfactory cores can be produced.

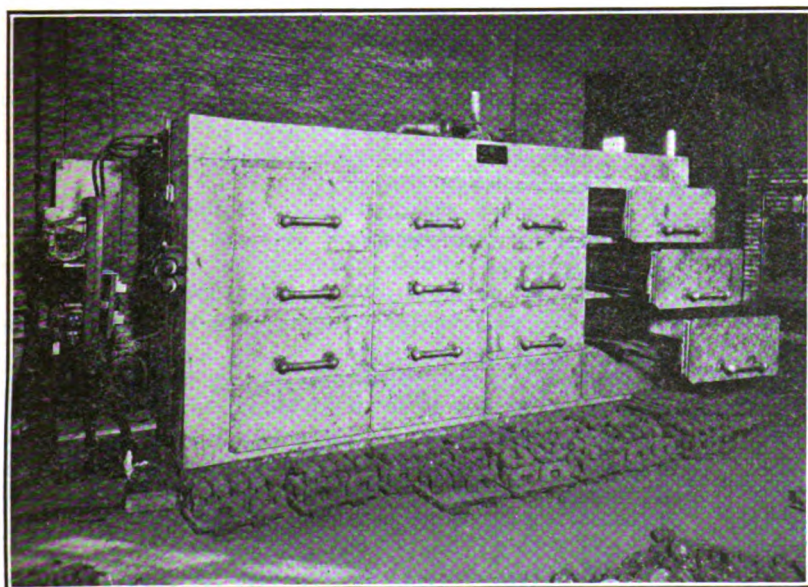
As a comparison we will compare oil in a like capacity.

Oil contains approximately 130,000 Btu. per gallon, with an average cost of approximately 8c per gallon developed to heat and delivered in the oven in the same relation as the cost of the electricity delivered.

By dividing the number of Btu. developed with one kwh. into those obtained from one gallon of oil, there will be established an equal basis of comparison on the same basic cost of 1c. This produces a result of 16,250 Btu. for 1c worth of oil, as against 3,417 Btu. for 1c worth of electricity. If we were to stop at this point there would be a decided advantage in favor of oil fuel, but investigation of the next consideration, namely, oven efficiencies, quickly reduces the oil advantage.

The calculated production of 16 lbs. of cores per kwh. consumed is based upon an electric oven efficiency of 80 per cent. In fuel fired ovens efficiencies above 10 or 15 per cent are rarely exceeded in actual operation. Therefore the difference in this percentage of efficiency reduces the value of the Btu. in oil to 2,440 Btu. in work produced, making the actual cost for heating nearly one-third greater than the electric cost.

The advantage of the electricity over oil in this question would be considerable increased by the consideration of gas, excepting in those locations where natural or by-product gas is available at very low figures, for the average cost of gas is today from \$1 to \$1.25 per 1,000 ft. Based on 525 Btu. contained per cubic foot or 520,000 Btu. for \$1, and notwithstanding a higher oven efficiency with the use of gas, in comparison with electric heat on the basis estimated herein, the net cost will be from 2 to 3 times greater.



Panel type electric core oven—self supporting draw type.

Using the figures contained in this brief calculation, any additional cost of operation when using electricity can be quickly obtained by the multiplication of its increase against the results noted herein.

While cost of operation is of course the predominating factor, there are many other conditions which must be considered in relation to their true value as applied to the finished product. For instance, in the fuel type oven the supplies of that fuel must be transported to the oven, in the case of gas or oil through pipe lines which demand a proportion of upkeep because of seepage losses, and in the case of coal by the expenditure of labor to deliver the fuel. Next there is the labor in fuel fired ovens for attention in the operation of the burner equipment, and incidentally the general upkeep, which is necessary in every equipment in which there is combustion.

In addition there is the important factor of the impossibility of close control of temperatures and uniform circulating conditions, which are of course necessary if uniform results are to be secured.

With relation to these conditions let us consider briefly the electric oven.

The fuel supply, temperature control and volume of that temperature is automatically taken care of by a simple instrument which records all of the facts of

will not add or detract from the object being treated as far as quality is concerned, excepting at the will of the operator.

With this basic condition as a starting point it is possible for a practical and experienced oven designer familiar with the problem of the development of heat through the use of electricity, to design an oven for the baking of cores in which ideal conditions exist. These ideal conditions are, namely, control of temperature and control of heat volume, plus the control of the flow of exhaust gases, or more practically speaking, the exhaustion of the moist contents of the binder mixture.

A core is made up of certain proportions of core sand and binder mixture in accordance with the particular requirements of the casting and the process operation of the manufacturer. Core binder mixtures are usually of either a linseed oil or pitch base, the pitch being a by-product of the paper manufacturing industry.

The particular wish is to obtain a sound core; by a sound core is meant a core which is baked thoroughly and uniformly from the center outward, for if the process is reversed, that is, the baking or setting commenced from the outside to the center at any temperature above that which is correct, the voids in the structure of the core quickly close, stopping the evaporation of the moisture in the center with a result that when it is put to use in the making of a casting, the excess heat and the pressure of the cooling metal crushes the core, releasing this moisture through the metal, causing blow holes.

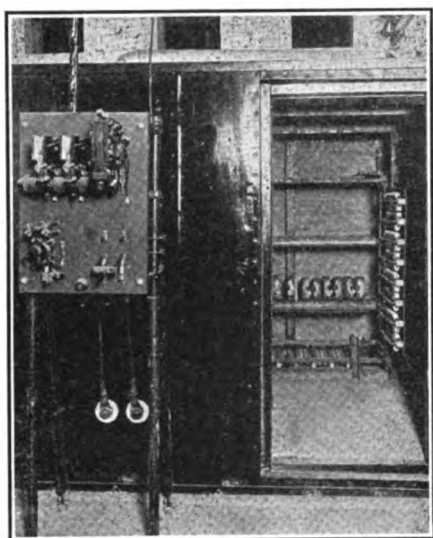
The process of exhaustion of moisture is principally the problem of heated air circulation to the proper requirements over the surface of the object to be treated, for air has a definite affinity for moisture absorption in proportion to its temperature.

Therefore the requirements that are desired to properly bake a core are uncontaminated hot air in volume and in circulation in direct reference to the capacity of moisture contained in the product to be treated, and with an easy control over both volume of air and temperature of heating.

With these particular points in view, it can be readily seen that the electric core oven adapts itself to these conditions, for with automatic heat and air exhaust control we have:

- (1) A unit built with the greatest possibilities of insulation, resulting in elimination of heat losses because of radiation.
- (2) Absolute control of both volume and temperature of heat.
- (3) The elimination of contaminating gases which are developed with types of fuels as referred to herein, which proportionately reduce the efficiency of air moisture absorption.
- (4) An absolute control over the speed of air volume exhaust.
- (5) An entire elimination of manual control with reference to heat development.

If the metal casting industry in general would pause and study the underlying causes of their rejection percentages, the cost of their present operation and the possible elimination of man power, then the electric core oven would truly come into its own, for today it stands as an absolute need and can no longer be classed as a "luxury" in even the smallest operations.—Ryan Review.



Core and mold oven solid wall type.

those deliveries, and automatically takes care of any operating conditions desired. No labor is necessary for its manipulation, and the upkeep is practically nil.

We have now considered the advantages of both cost saving and operation, and have reached the determining factor, namely, which system will produce the most perfect core.

It is our contention, and the basis of this contention will be set forth herein, that the electric oven is the ideal medium, both from the operating cost standpoint and from the standpoint of perfect product.

Electric heat is too often confused as some mysterious and unknown factor, a heat which will deliver new factors of strength in the treated product. Practically it is the simplest form of heat which has yet been developed. It is purely heat that is entirely free from contaminating gases, is subject to instantaneous control both as to its flow and to its temperature and

The following is a brief summary of some of the principal articles published in Iron Trade Review from September 27 to date:

September 27—

Conditions in the steel market remain under check, as buyers pursue a waiting policy. Sheet production in the Mahoning valley is the lowest since July. Wire buying, however, has increased 40 per cent since the low point in July. Pipe and tin plate demand is good. Rail makers, with the exception of the Colorado mill, are booked full until June, 1924. The new orders of United States Steel Corporation averaged 31,391 tons daily the first three weeks in September, or about 65 per cent of finishing capacity. The steel corporation's operations this week are up to 90.3 per cent of ingot capacity. Sheet bars still are sold at \$42.50, Youngstown, though some concessions appear in billets and slabs. The continued decline in pig iron has forced downward Iron Trade Review's composite of 14 leading iron and steel products, the index this week being \$44.17 against \$44.70 the week preceding.

The business trend section shows that good fall trade is indicated, though the crest of industrial activity appears to have been passed.

The British iron and steel trade remains depressed, though Japan has placed substantial orders for sheets for reconstruction purposes.

The Southern Ohio Pig Iron & Coke Association at its annual meeting in Columbus, Ohio, sponsors a plan for the purchase of coal according to analyses, similar to the purchasing of iron ore.

October 4—

Expectations of better buying of steel in the near future in considerable degree are based upon the possibility of a revival of railroad equipment orders on a heavy scale. Large railroad purchasing programs are being prepared for release during the last quarter. Rail buying keeps up well. Inquiries for tin plate for 1924 are developing. Japanese buying, especially in sheets, is beginning to appear in larger volume. Pig iron production in September fell off for the fourth consecutive month, now being back practically to the January rate. The total output in September was 3,123,611 tons, against 104,120 tons in August. The average daily rate of 104,120 tons in September was 6.4 per cent below that of August. Iron Trade Review's composite of 14 leading iron and steel products this week is \$44.23, weakness in pig iron continuing to be the dominating factor.

Of interest in the European market situation is the report that German producers have just concluded sales of several thousand tons of nails and plain wire to Japan at the equivalent of \$72.64 f.o.b. The French are organizing a selling syndicate to handle steel released from the Ruhr district.

The business trend section shows that autumn trade expansion is appearing, and that the outlook has considerably improved.

A series of articles is begun in this issue on heat treating, its principles and applications, by Charles H. Fulton, director of School of Mines and Metallurgy, University of Missouri; Hugh M. Henton, consulting metallurgical engineer and assistant professor of metallurgy and mining, State College of Washington, and James H. Knapp, furnace engineer, Tate-Jones & Company, Pittsburgh.

October 11—

A moderate broadening of buying and inquiry is spreading over the leading steel products, and sentiment appears to be more cheerful. Ingot output in the United States in September declined to a daily rate of approximately 132,524 tons compared with 136,214 tons in August, a loss of 2.78 per cent. Production in September was at the annual rate of 41,101,000 tons, compared with a corresponding rate of 42,245,000 tons in August. Falling pig iron prices have depressed the composite price of 14 iron and steel prices to \$44.06.

Japan has closed for more German tonnage, placing 25,000 tons of bars and shapes at \$38.73, Hamburg.

An account of the annual safety congress of the National Safety Council, Buffalo, October 1-5, shows that the steel industry is leading in the national safety movement.

New short haul rates on steel, representing an advance, are postponed to February 4 by the Interstate Commerce Commission in deference to protests of various steel companies and commercial organizations.

Members of the National Tool Builders' Association in convention at Lenox, Mass., discuss progressive policies for improving the status of the industry.

October 18—

October steel business is keeping well ahead of that of September, the railroads leading with renewed buying. Further tonnage is placed for Japanese account, and building work in the United States is heavier. Soaring prices for coke in Germany and France have directed large inquiries for furnace fuel to this country. The composite price of 14 leading iron and steel products this week stands at \$43.90 against \$44.06 a week ago. British railways are placing orders for new equipment, and the European situation, outside of Germany, appears to be improved.

The business trend section shows that more constructive events are occurring. The improvement in the steel trade and upward movement of agricultural prices are cited as favorable developments.

An article is presented in this issue pertaining to the government of agricultural prices are cited as favorable developments.

An article is presented in this issue pertaining to the government's Aberdeen proving ground, and what it means to iron and steel manufacturers.

October 25—

Inquiries are made for 25,000 to 30,000 railroad cars and new vessel construction is demanding a considerable tonnage of steel. Bids are asked on 15,000 tons for extensions to the Ford Motor Company's plant at Detroit.

The composite price of 14 leading iron and steel products this week is \$43.70, this being largely due to the continuing decline in pig iron. Valley iron has sold at \$22.50. Japanese reconstruction needs are furnishing a larger number of orders. An Ohio independent maker has taken 15,000 tons of sheets. A large tonnage of sheet bars also has been purchased for conversion in Japan.

Lake traffic is being delayed by rough weather, and it seems that the 60,000,000 ton mark in iron ore will not be attained this year.

The POWER PLANT

Power Plant Management

Efficient Combustion Practice—Effecting Savings Through Control of CO₂

By ROBERT JUNE†

BLUE gas analysis in and of itself will not improve boiler room efficiency any more than taking the pulse and temperature of a fever victim will cure him of his ills. Flue gas analysis apparatus, like the clinical thermometer, is of value only as a basis for intelligent action.

What Flue Gas Analysis Will Enable You to Accomplish.

Accurate determination of flue gas analysis will enable you to accomplish the following results:

1. Improve methods of handling fire.
2. Improve draft regulation.
3. Detect air infiltration.
4. Indicate necessity, if any, to provide secondary air supply.
5. Indicate needed changes in design and construction of furnace.

In addition to the above the installation of flue gas analysis apparatus in the boiler room will increase the morale of the entire boiler room crew. Efficiency is infectious. Being stimulated to employ better fir-

This is the third in a new series of articles by Robert June, the well known authority on power plant management. The articles are written from the point of view of the managing executive and deal with the dollars and cents end of power plant operation and maintenance. Succeeding articles deal with such live topics as Safe and Efficient Boiler Operation, Stoker Operation and Maintenance, What Management Should Know About Coal and Ash Handling Equipment, Steam Piping, Efficient Turbine Operation, etc. The series is timely and should prove of value to our readers.

ing methods, they will handle other parts of their work in a better, more economical manner. Taking up the various points listed above we find:

Improved Methods of Handling Fires.

Thin fires, through which holes develop, insure low CO₂. The fireman can't always tell by inspection when his fires are too thin. He may be careless, and if there are no CO₂ records to check him up, no one may be the wiser. There is no such thing as a fixed

adjustment in the operation of a boiler. Load conditions vary and the rate of combustion must follow suit or the steam pressure will drop. This calls for readjustment of the fire. These variations in the fire cannot be made anything like as correctly without CO₂ equipment as with it. With hand fired boilers a continuous CO₂ record shows how often the fires were replenished, how long fire doors were left open, when the fires were cleaned and how long it took to clean them. In stoker fired boilers equivalent changes are indicated.

Improved Draft Regulation.

Unnecessarily high drafts decrease the percentage of CO₂. On a test of a Manning boiler burning No. 1 buckwheat, a fairly uniform relation between the

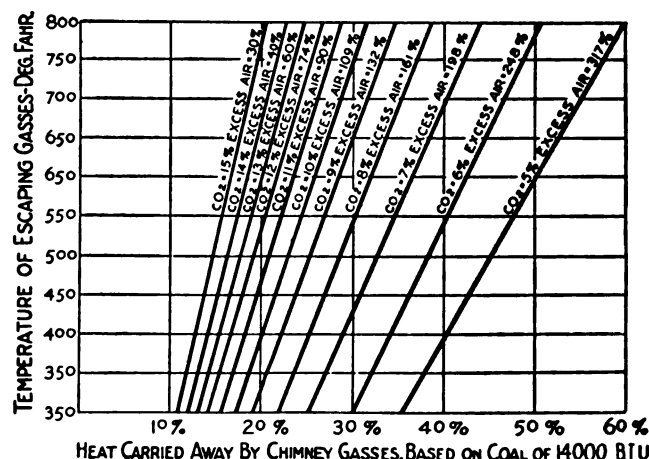


FIG. 1—Chimney losses in relation to CO₂. Actual losses in Btu.

boiler draft and the amount of CO₂ was indicated. With a draft of 0.20 in. a CO₂ content of 8 per cent was found. Reducing the draft to 0.18 increased the CO₂ to 9 per cent. A further drop in draft to 0.16 in. produced a 10 per cent CO₂. Cutting the draft to 0.14 an 11 per cent increase was established. With a draft of 0.12 in., the CO₂ content was increased to 12 per cent. Here the improvement ceased. A further drop in draft resulting in a decrease in CO₂, showing that for the particular load demand and the particular condition of the fuel bed during the test a draft of 0.12 in. was most economical.

With another fuel and under other conditions a different draft would be required. The economical draft can be more readily determined with the aid of CO₂ analysis apparatus than in any other manner.

*Copyright, 1923, by Robert June.

†Associate Member, A. S. M. E.

Detect Air Infiltration.

The presence of leaks permitting the infiltration of air into the setting through the brickwork or doors can be detected readily by means of CO₂ apparatus. If the percentage of CO₂ is not increased by better handling of fires or by adjusting the draft, then it is time to examine the setting. A lighted candle passed slowly over the brickwork and door joints will indicate air infiltration as the flame is sucked in.

Indicate Need of Secondary Air Supply.

Each pound of fuel of a certain composition requires a certain fixed weight of air for complete combustion. In addition to this fixed amount an additional percentage of excess air must be provided so that despite faulty distribution of the air supply there will be a particle of oxygen available for each particle of carbon or other combustible to be consumed. Whether the amount of excess air is high or low determines boiler efficiency. As the amount of excess air is measured by the percentage of CO₂, we can determine by the use of CO₂ indicators whether we have an adequate supply of air, properly distributed.

Indicate Need to Change Furnace Design.

Insufficient combustion space is another direct cause of low CO₂. If we have carefully checked over our firing methods, draft regulation, condition of our settings and air supply, and if we still find that we are getting low CO₂, it is time to examine furnace design and furnace volume. Hundreds of furnaces are reconstructed every year to the profit of the owners, as a result of the findings of CO₂ indicators.

Relation Between CO₂ and Losses in Dry Chimney Gases.

The loss due to heat carried away by dry chimney gases for varying percentages of CO₂, and different temperatures of exit gases is shown in Fig. 1 and Fig. 2. Fig. 1 shows the actual loss in Btu. Fig. 2 shows

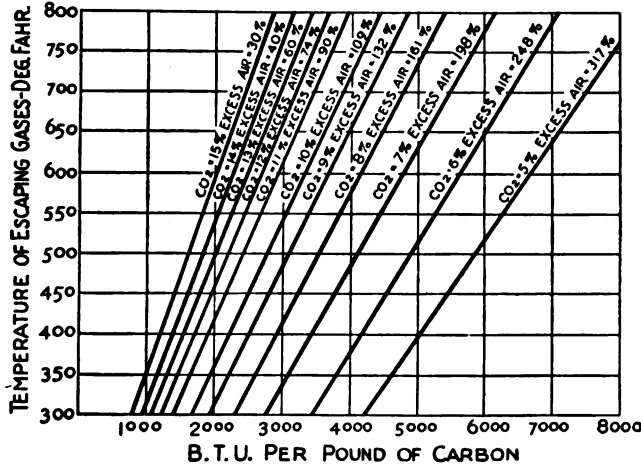


FIG. 2—Chimney losses due to temperature. Percentage loss in relation to total fuel value.

the percentage loss of the total value of the fuel, based on a coal of 14,000 Btu. Table I gives a rough approximation of the per cent loss up the chimney for the several major classes of fuel.

CO₂ Indicators and Recorders.

A great many different types of apparatus have been developed for indicating and recording CO₂. In describing and illustrating a number of these, we do

TABLE I—PER CENT LOSS UP THE CHIMNEY FOR VARIOUS FUELS

Per Cent CO ₂	Carbon	Anthracite Coal	Bituminous Coal	Fuel Oil
	Loss	Loss	Loss	Loss
3	67.2%	61.8%	58.1%	49.4%
4	50.5	47.1	44.6	38.9
5	40.7	38.3	36.5	32.6
6	34.0	32.3	31.1	28.4
7	29.3	28.1	27.2	25.3
8	25.8	24.9	24.3	23.1
9	22.9	22.4	22.1	21.4
10	20.7	20.5	20.3	19.9
11	18.9	18.9	18.8	18.8
12	17.4	17.5	17.6	17.9
13	16.1	16.4	16.5	17.1
14	15.0	15.4	15.6	16.4
15	14.1	14.6	14.9	15.7
15.7				15.3
16	13.3	13.9	14.2	
17	12.6	13.2	13.6	
18	11.9	12.6	13.1	
18.6			12.8	
19	11.3	12.1		
19.5		11.8		
20	10.8			
21	10.3			

not impute any lack of merit to makes of apparatus not mentioned, or to those not illustrated or only described briefly.

The Orsat.

The Orsat (Fig. 3) is employed for volumetric analysis of a single sample. The principles employed in the equipment illustrated are used in practically all of the portable appliances on the market. A measured sample of gas having been drawn from the stack, is forced successively through pipettes containing solutions of caustic potash, pyrogallic acid, and cuprous chloride in hydrochloric acid, respectively, thus absorbing the carbon dioxide, the oxygen and the carbon monoxide, the contraction of volume being measured in each case. The original Orsat apparatus is bulky, fragile and slow, but it is accurate. Some recent modifications have considerably improved the apparatus. There is room in every power plant for the Orsat for the following services:

1. To determine the maximum CO₂ which can be carried while still securing complete combustion.
2. To inspect settings for air infiltration.
3. To check up the continuous CO₂ recorders.

By itself the Orsat is inadequate as a control for the firing operations of a boiler plant. It is decidedly better than nothing however, and as it is not expensive it should be employed in every plant whether CO₂ recorders are installed or not.

Foxboro CO₂ Recorders.

In the Foxboro recorder (Fig. 4), as in the Orsat, a solution of caustic is used for a reagent. The motive power is obtained from a constant flow of water and the periodic operation of an automatic syphon, the amount of water required per day being approximately two barrels. There are only three moving parts—the clock movement for rotating the chart, the pen-actuating float, and the dotting mechanism.

The operation of this particular machine is as follows: The water flows through the coils into measuring vessel (3) and traps a definite volume of gas in bulb (5), forcing it over through tube (6) to absorption vessel (2), where it bubbles up through caustic

solution (7), which almost instantly absorbs the CO_2 gas present. Above the caustic solution is a layer of oil, and above that is gas chamber (9). A float tube (10) terminates in a tube (11) which extends through the oil almost to the level of the caustic solution. Pressure in chamber (9) causes oil to flow through the tube (11) into float tube (10) which encloses a float, to the upper end of which is fastened a pen (13). The distance the pen will rise depends upon the quantity of gas forced into the gas chamber by the rising water—the gas reaching the gas chamber being the residue of the original sample after CO_2 is removed. The water rising in the water-float tube (14) raises a float which operates dotting mechanism (16), causing the pen to press against the chart.

The water now syphons out through (17) and, as the syphon takes water away faster than it is delivered, the float in (14) drops, releasing pen (13). As the water continues to syphon out, the pressure in the gas chamber decreases and eventually balances to atmospheric pressure through the exhaust pipe (22), the float in tube (10) dropping to normal position. Water passing through the syphon operates aspirator (18), creating suction through water seal (19), and

sure in a stream of gas flowing through two apertures, caused by absorption of its CO_2 content.

The apparatus consists of three principal parts, namely, the CO_2 meter proper, the recorder for the engineer's office and the auxiliary boiler front indicator for the fireman. The CO_2 is extracted in the CO_2 meter proper. The CO_2 meter, in turn, actuates the recorder and indicator.

Republic CO_2 Recorder.

The Republic depends upon the flow of water for its operation. It is constructed that a variance from

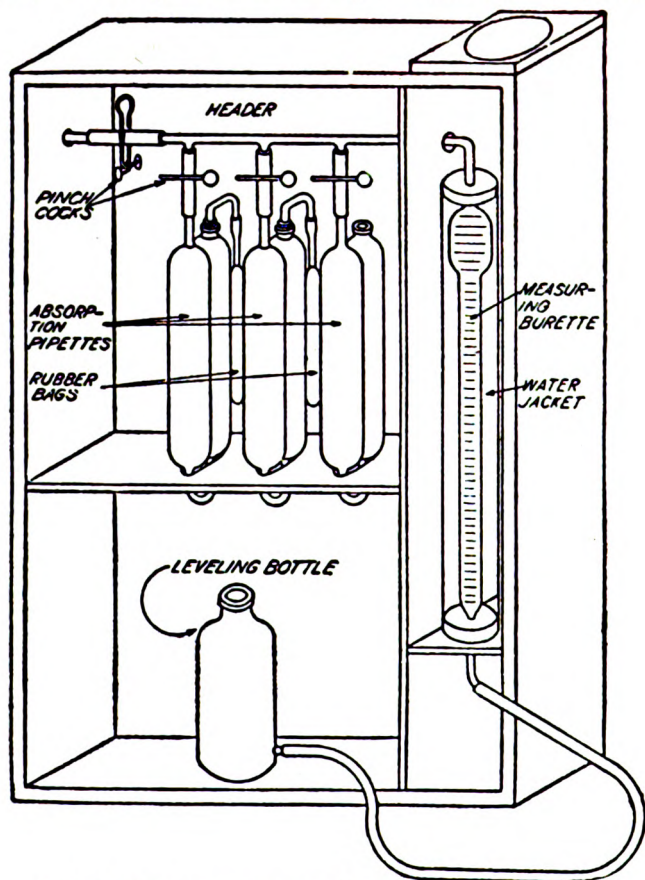


FIG. 3—Orsat machine used for gas analysis by volume.

draws flue gas through the chamber of filter (20). Part of this gas is drawn through the filter into measuring vessel (3) through intake pipe (21). When the syphon (17) breaks, the pressure of the gases in measuring vessel (3) balances, and the cycle is resumed by the rising water trapping the unit quantity of gas in bulb (5).

Uehling Apparatus.

The principle involved in the operation of the Uehling CO_2 meter depends upon the change in pres-

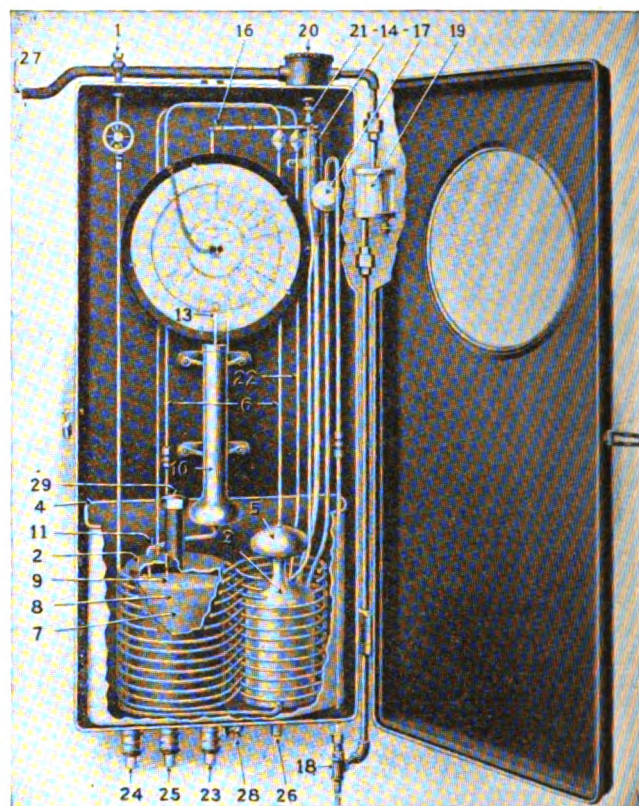


FIG. 4—The Foxboro CO_2 recorder.

a minimum supply to a full open valve will not affect its proper functioning. The gas is drawn from the furnace to the instrument by means of a water jet and aspirator. It, like the Foxboro, is a chemical machine.

Precision CO_2 Recorder.

This instrument is likewise operated by a small stream of water. Individual gas samples are taken, analyzed with the aid of chemicals and the results recorded. After one sample has been analyzed another is taken immediately and duly recorded.

Hays Automatic CO_2 Recorder.

In the operation of the Hays CO_2 recorder, Model B (Fig. 5), a continuous stream of gas is drawn rapidly from the last pass of the furnace and at regular intervals the machine takes a measured sample of this gas, causes the CO_2 to be absorbed by means of a caustic potash (KOH) solution and the pen to move on the chart to a point representing the per cent by volume of CO_2 contained in it. Such variables as temperature and pressure of the gas sample, evaporation of water and changes in the specific

gravity of the KOH solution are automatically controlled by the machine.

Water from the regular source furnishes the motive power for the Hays recorder; about one gallon is required for each operation. This flows into the aspirator A and thence into the overflow box B. The speed of operation (closeness of lines on the chart) is governed by the amount of water admitted to the re-

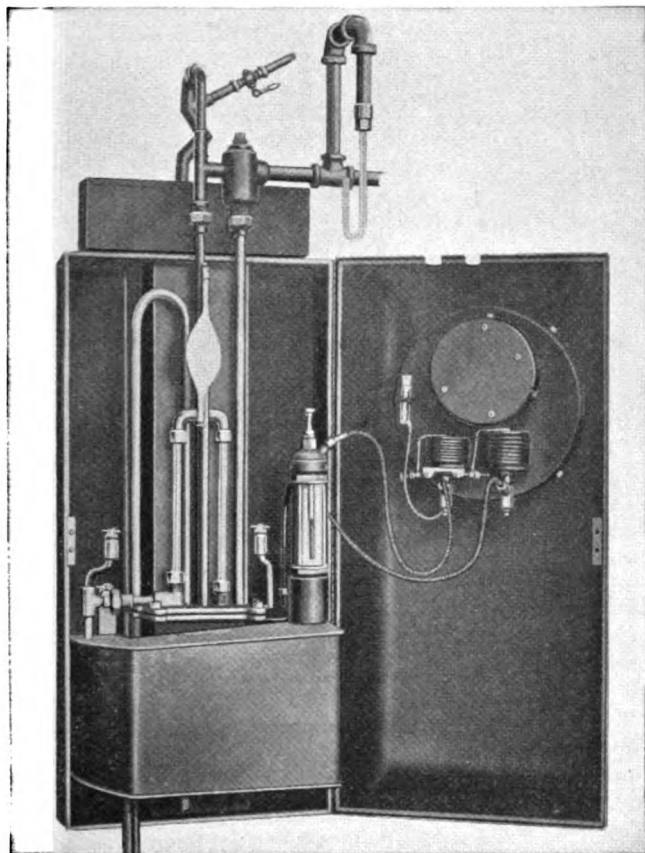


FIG. 5—Hays CO₂ recorder.

corder through the sliding sleeve regulating valve C. The range of adjustment is from one to four minutes, but a cycle every two and three-fourths minutes is recommended.

Bacharach Electrical CO₂ Meter.

The S. & H. CO₂ meter (Bacharach), Fig. 6, operates on a principle entirely different from that of the chemical CO₂ indicator; it makes use of the physical property of heat conduction of the gases. The arrangement of the motor is shown diagrammatically in the illustration. The "tester" consists of two sets of blocks, one set containing chambers "A" and the other chambers "B." In the center of each chamber is a thin platinum wire always central, regardless of heat expansion. "A" are the measuring chambers through which the flue gas passes slowly; "B" are the comparison chambers, containing air at room temperature. The electrical system is arranged in a Wheatstone bridge circuit, of which the four branches are the four platinum wires in the two blocks. Across the mid points of the bridge is connected the sensitive indicating galvanometer C. If desired the recording galvanometer F, which may be placed at any reasonable distance from the measuring instrument, can also be connected into the circuit.

The electrical energy is obtained from a small storage battery G through a variable resistance J, which is adjusted to give constant current through ammeter H.

The flue gases consist of carbon dioxide (CO₂), carbon monoxide (CO), oxygen, nitrogen, and water vapor, with traces of other gases. Nitrogen, oxygen, carbon monoxide and air all have practically the same heat conductivity, but CO₂ has 40 per cent less conductivity, and water vapor a conductivity about 30 per cent greater than that of air. The air in the comparison chamber is kept free from water vapor by the presence of hygroscopic chemicals, and the flue gases having passed through a cooler which also acts as a dryer, contain a very small, but practically constant, quantity of water vapor, hence the only variation occurring in the heat conductivity of the gases depends directly on the percentage of CO₂ in the flue gas.

As the electric current flows through the platinum wires, the heat which is generated in them is transmitted through the gases to the walls of the chambers. The gases in "A," containing CO₂, transmit the heat less readily than the air in "B"; and the wires in "A" become hotter than the wires in "B"; its resistance therefore increases, unbalancing the circuit and causing a deflection of the galvanometer, to an extent depending on the percentage of CO₂ present. The galvanometer is calibrated to read directly in per cent of CO₂.

Arndt Gas-Balance.

This instrument, for the description of which we are indebted to Mr. John B. C. Kershaw, is illustrated in Fig. 7. The action of the Arndt apparatus is based upon direct measurement of the weight of the gases, CO₂ being heavier than air. In the absence of moisture, and at a fixed standard of temperature, the variations in density serve as an index of the CO₂ contents of the gases. The method of operation of the instrument is as follows: The gases are drawn continually from the flue at E by means of the steam-

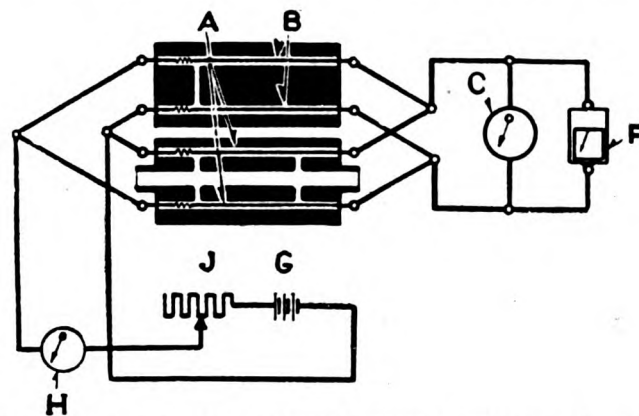


FIG. 6—The S. & H. (Bacharach) recorder which employs the Wheatstone bridge circuit.

jet D. They pass first through the filter A, then through the drying tubes B, and finally through the weighing-bulb C. The scale of the balance is graduated, so that the percentage of CO₂ can be read off directly. With a recording attachment of the usual type, a permanent record of the variations is obtained.

(Continued in December)

TRADE NOTES

Richard W. Yerkes, formerly general manager of the Link-Belt Company's Philadelphia plant, has been appointed treasurer of the Link-Belt Company, succeeding Mr. B. A. Gayman.

Mr. Gayman was selected by Mr. Charles Piez, president of the Link-Belt Company, to head the newly acquired Meese & Gottfried Company of San Francisco. The new company will operate under the name Link-Belt Meese & Gottfried Company, San Francisco.

Mr. Yerkes will be located at the Link-Belt Company's general offices at 910 South Michigan Avenue, Chicago.

Emmet B. Carter, for a number of years chief engineer of the Midvale Steel Company of Philadelphia and later construction engineer of the Cambria Steel Company of Johnstown, is now located in New York City as chief engineer of The Barrett Company.

The Irving Iron Works Company of Long Island City, manufacturers of Irving Subway Grating and Safesteps, held a three day sales convention, September 12, 13 and 14. Headquarters were established at the Hotel Lorraine, Fifth Avenue and 45th Street, New York City, and a well defined program was pushed through swiftly and smoothly.

Wednesday, September 12, the convention opened with a lunch at the Hotel Lorraine. In the afternoon the entire sales force journeyed to Long Island City and inspected the plant. Some 40 salesmen were divided into four groups and the manufacturing of the product was shown them from the raw material stage to completion. While inspection was in progress a buffet luncheon was served in the Sales Department, and the girls employed in the Sales Department, acted as hostess. Wednesday evening a banquet was given to the Sales Force, Mr. W. E. Irving, president; Mr. P. L. Price, general manager; Mr. Wightman, advisory counselor; Mr. Griggs, Houston representative; Mr. Vonier, Milwaukee representative, and Mr. W. McKee of the Production Department were the speakers.

On Thursday morning at 9 a.m. the business meeting was called and lasted until 12 midnight, with brief adjournments for luncheon and dinner, and an inspection trip to the Hell Gate Power Plant of the United Gas & Electric Company, New York City.

On Friday a clambake was given at the home of Mr. Irving, at Glenbrook, Connecticut and proved a delightful windup to a thoroughly enjoyed and valuable convention.

C. B. Porter, John T. Dillon and Stewart F. Hancock, receivers of Sizer Steel

Corporation of Buffalo, wish to announce to the trade that they have resumed the manufacture of all kinds, grades and finishes of commercial forgings, in addition to present output of rolled bars, die blocks, oil well steels and spiral stems.

The Detroit Stoker Company announces the appointment of E. L. Beckwith as district manager in charge of the company's Chicago office, Illinois Merchants Bank Bldg., 230 South Clark Street, Chicago. Mr. Beckwith is an engineer with many years' experience in stoker sales work.

TRADE PUBLICATIONS

The Torchweld Equipment Company, 224 North Carpenter Street, Chicago, has issued a new catalog covering its complete line of oxy-acetylene welding and cutting apparatus, lead welding, soldering, brazing and decarbonizing units, gas pressure regulators, automatic machines, generators and supplies. The catalog contains cross sectional views of equipment with detailed explanation. The catalog is 8½x11 in. and consists of 40 pages. A copy may be obtained on request.

The W. A. Jones Foundry & Machine Company, Chicago, has recently published two new catalogs, copies of which will be mailed free to interested parties on request. Catalog No. 27, Pulleys, is full of new and valuable information on cast iron pulleys, such as weights, illustrations and extra lists for special types, rubber covering list; also describes, illustrates and lists "Lemley" ball bearing loose pulleys, and ring oiling loose pulleys. Steel, wood and paper pulleys are also listed. Catalog No. L-28, Friction Clutches, contains 56 pages of valuable data on Lemley friction clutches, most of which is entirely new. Sleeve clutches, cut-off couplings, clutch pulleys, ball bearing clutch pulleys, gas engine clutch pulleys are completely covered with price lists, dimensions, illustrations, horsepower ratings, etc.

The October bulletin of the Copper and Brass Research Association tells in 16 pages, impressively illustrated, the value of its products in every day use. The stories of the Old Bell of Del Valle Ranch, now 127 years old, and the Tibetan brasses of unknown age, give firm evidence of the lasting quality of these metals.

As a souvenir of the International Steel Exposition held by the American Society for Steel Treating in Pittsburgh, October, 1923, the Crucible Steel Company of America issued and are distributing an historical essay by Dr. John A. Mathews, entitled, "Economic and Metallurgical Aspects of Iron in Colonial

Days." Its introduction strikes its keynote: "From the rising of the sun to the going down of the same" your life—your work and play, are daily influenced by the broad scope of activities of the Crucible Steel Company of America. The basic sources of wealth are agriculture, mining and manufacture, and in each of these fields tools are used and the material for all these are the products of this company—the world's largest maker of fine crucible and electric steels. Twelve plants in three different states are engaged in the manufacture, and 30 warehouses in this country and abroad are engaged in the distribution of our standard products. For four generations our trademark brands have been known and respected throughout the civilized world, wherever mining, agriculture, or manufacturing is carried on. * * * "Great oaks from little acorns grow," and so from the humble beginning of the iron industry in America—300 years ago—so entertainingly told in the following historic sketch, has developed a great institution serving the nation in peace and in war, engaging in research and investigation continuously to develop new products, to improve the old ones, and to advance the industrial supremacy of our country, and the happiness and well-being of its people.

For the first time in America, all the details of a liquefaction plant are available to any interested person. Oxeco plants, in practically every large industrial community, are open to inspection. The plants are simple in construction and easy to operate, requiring only one ordinarily intelligent workman to make them produce pure oxygen from the air in the most economical way. In a beautifully illustrated booklet, "Oxygen from the Air," issued by M. Keith Dunham, Chicago, the process is described.

COMING MEETINGS

November 19-22—Electric Power Club fall meeting at French Lick Springs Hotel, French Lick, Ind. S. N. Clarkson, Rockefeller Bldg., Cleveland, is secretary.

December 3-6—American Society of Mechanical Engineers annual meeting, New York. Calvin W. Rice, 29 West Thirty-ninth Street, New York, is secretary.

December 3-8—Power and Mechanical Engineering National Exposition, Grand Central Palace, New York. Fred W. Payne and Charles F. Roth, Grand Central Palace, New York, are in charge.

December 5-8—American Institute of Chemical Engineers winter meeting, Washington. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y., is secretary.



Edward C. Collins, just elected president of the Crucible Steel Company of America, was formerly assistant to Horace S. Wilkinson, chairman of the board of directors, and succeeds Dr. John A. Mathews, resigned. Mr. Collins became affiliated with the iron and steel industry through his activity in iron ore shipping on the Great Lakes, practically his whole career being devoted to ore transportation. His first experience in shipping on the lakes was obtained while connected with M. A. Hanna Company, Cleveland, with which he started as an office boy in 1892. He joined the Carnegie Steel Company in 1897 when that company started to handle its own ore. The Carnegie Company had then acquired a three-quarters interest in the Lake Superior Iron Company, carrying a fleet of four ships. The Pittsburgh Steamship Company was organized in 1899 as a subsidiary of the Carnegie Steel Company. The fleet of this subsidiary was under the supervision of E. S. Mills as general manager of the Pittsburgh Company and Mr. Collins worked under Mr. Mills. Mr. Collins was made general agent when the United States Steel corporation was formed in 1901 and the Pittsburgh Steamship Company became a separate subsidiary. In 1904 he was made traffic manager and several years later vice president in charge of traffic, which position he held when resigning to become affiliated with the Crucible company.

The duties as president of the Crucible company made such demands upon the time of Dr. Mathews, whom Mr. Collins succeeds, as to interfere with the research and development of metallurgy, to which the former has devoted most of his life and in which field he has attained

conspicuous success. Dr. Mathews now will devote his entire time to work in the metallurgical field.

Percy E. Wright, consulting mechanical engineer, has been appointed assistant sales manager of the Reeves Bros. Company, Alliance, O., erector of steel tanks, oil refinery equipment, etc., and will be in charge of its western business with headquarters at 2012 L. C. Smith building, Seattle, Wash.

J. C. McQuide, manager of the newly installed Buffalo office of Blaw-Knox Co., of Pittsburgh, manufacturers of steel products, was formerly located at the home office.

Frank Cotington has recently been appointed superintendent of the foundry department of the Holyoke Machine Company, Worcester, Mass. Mr. Cotington was formerly with Wm. Cramp & Sons Company, Philadelphia.

Gunnar Dillner managing director of Trafikaktiebolaget Grangesberg Oxelosund of Stockholm, Sweden, together with S. Frisell of the same company, arrived in the United States last week for an extended visit.

Fred Bennett, Buckeye Steel Castings Company, Columbus, O., has been elected secretary of the metals section of the National Safety council.

Sir Alfred Yarrow, chairman of Yarrow & Company, shipbuilders, Glasgow, Scotland, has returned to Great Britain from a trip to the United States which included an inspection of the Yarrow company's properties in British Columbia.

G. F. Gerrard, formerly superintendent of the plant of the Northwestern Malleable Iron Company, Milwaukee, has been

appointed manager of the Jamestown Malleable Products Corporation, Jamestown, N. Y.

The United States Steel Corporation, acting through a subsidiary, the Lafayette Mining Company, recently purchased a large fluorspar property in the Kentucky district. The purchase price was not announced. The property had been held under option for some time, and was thoroughly diamond drilled before the deal was concluded. The holdings consist of over four miles on the best vein in the district, and represent a large proportion of the field's producing capacity. This follows the action of other steel companies in securing fluorspar reserves.

Elmer T. McClary, district manager of the Youngstown Sheet & Tube Company at Youngstown, Ohio, was successfully operated on for appendicitis and is on the road to recovery in a Cleveland hospital.

Burford, Hall and Smith, American Trust and Savings Bank Bldg., Birmingham, Ala., have been appointed district representatives for the sale of Diamond Soot Blowers by the Diamond Power Specialty Corporation of Detroit.

Dean R. Wilson is president of the recently formed Anchor Drawn Steel Company, Farmers Bank Building, Pittsburgh. He was for many years vice president and treasurer of the Carbon Steel Company, Pittsburgh, and also was director and treasurer of the Kittanning Iron & Steel Mfg. Company, resigning from both organizations two years ago. Mr. Wilson has been identified with the steel industry in the Pittsburgh district since 1902.

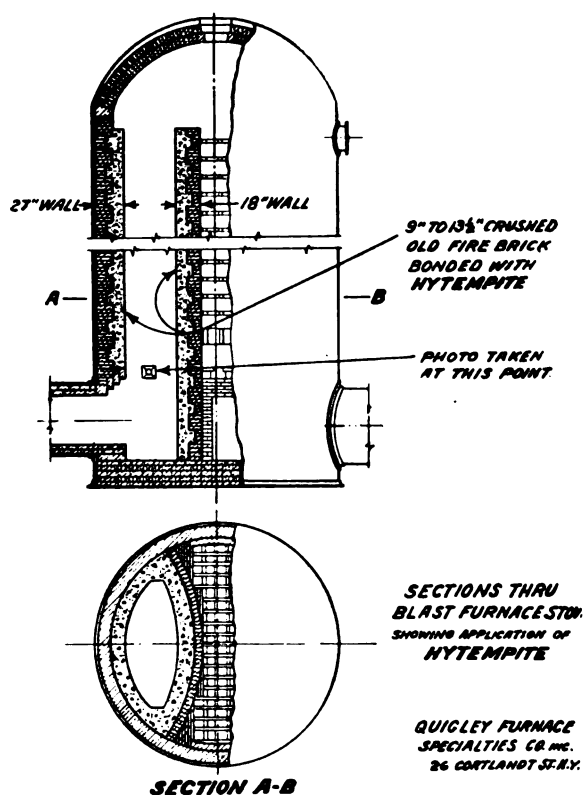
WITH THE EQUIPMENT MANUFACTURERS

Monolithic Lining for Hot Blast Stoves

The relining of the hot blast stoves using monolithic construction of refractories has been successfully applied to a two-pass side combustion stove at Hamilton, Ontario, in the plant of the Steel Company of Canada.

This is believed to be the largest "one-piece" lining ever installed and its success has already been demonstrated through several months' continuous service.

Old blast furnace linings were salvaged by crushing to uniform size and using all material which would pass through a $\frac{1}{4}$ -in. mesh screen. Old brick are particularly suitable for this



work. In their initial service the impurities have been burned out and shrinkage removed.

This material was added to diluted high temperature cement (Hytempite) to form a stiff plastic material about the consistency of molding sand. Old fire brick were used for building the wall to back up the monolithic lining, leaving header courses projecting. This brick work was first coated with a thin hytempite wash after dust and loose particles had been removed.

After diluting hytempite in a mortar box to the consistency of pancake batter, the crushed old brick including the fines were mixed in till a molding sand consistency was reached. The proportions used were 50 lb. of hytempite to each 100 lb. of crushed old fire brick. Forms were made of lumber about 1 in. thick and 30 in. of form in height were used at a time.

This mixture, made in suitable sized batches, was then rammed in behind these forms. A bonding coat of hytempite batter was brushed over each section of the old brick work just prior to ramming the material. This served to tie the rammed material to the standing wall.

The size of the chamber lined is approximately 24 ft. in height by 15 ft. in longest axis.

Fig. 2 shows how the header courses support the monolithic lining which is 9 inches thick at the thinnest point and about 13 inches thick at the thickest point.

As each 30-in. section was rammed the forms were removed and raised 30 inches for packing the next section. This procedure was followed until the top of the wall was reached.

After the walls were completed they were allowed to air dry for 24 hours and then the entire surface covered with a wash coat of hytempite batter. This gave a smooth hard finish to resist hot gas action.

The blast furnace was blown in on January 2, 1923, and the stoves have been in constant operation ever since with very satisfactory results.

The lining was installed under the direction of H. G. Hilton, superintendent of the plant, with the assistance of W. H. Gaylord, Jr., field service engineer of Quigley Furnace Specialties Company, 26 Cortlandt Street, New York.

Steel Mill Ventilating

Motor drive is now accepted as the "thing to be done" in the mill of today. This is so because of the proven greater reliability of the electric drive in operation over the steam engine, its greater economy and better power distribution, diminished maintenance charges and greater speed. Ventilation of motors has likewise advanced from the position of a necessary but minor auxiliary to that of a major element in efficient plant operation. For this reason interest attaches to the ventilating equipment about to be installed in the newly electrified mill No. 2 at the Lackawanna plant of the Bethlehem Steel Corporation.

This equipment will consist of two No. 9 double width Turbo Conoidal Blowers (manufactured by the Buffalo Forge Company of Buffalo, N. Y.), each capable of delivering 60,000 cu. ft. of air per minute. Both will be of top horizontal discharge. The blowers, requiring 44.5 bhp., will operate at 715 rpm. and will be direct connected with electric motors. Bearings for these fans will be mounted on independent pedestals.

Two Carrier Air Washers of standard gauge will also be installed to clean and cool the air delivery by the blowers. These washers use a very finely divided spray which gives the best cooling and cleaning effect. The moisture is prevented from passing thru the ventilating pipes by vertically inclined eliminator plates with projecting lips, which retain the water and return it to a settling tank. This water is recirculated after being strained. The amount of dust collected in the settling tank is considerable and the cooling effect produced by evaporation of the spray is important. This type of spray cooler is the same as now generally used on steam turbine generator sets.

A 4-in. single stage centrifugal pump operated at 1,440 rpm. and manufactured by the Buffalo Steam Pump Company will supply the pressure for these washers. The pump itself will be fitted with brass impellers, brass glands and a brass covered shaft.

Some Pointers on By-Product Coke Oven Operations

Motor Benzol as Substitute for Gasoline

Experiments in the operation of internal-combustion engines with motor benzol, conducted by the Department of the Interior at the experiment station of the Bureau of Mines at Pittsburgh, indicate that this type of fuel may serve as a satisfactory gasoline substitute when refined by the use of sulphuric acid or silica gel. The same tests developed the fact that crude motor benzol cannot be used satisfactorily until after the removal of certain compounds which form gummy deposits and eventually stop the engine. No engine trouble whatever developed when acid-refined or silica gel refined motor benzol fuel was used.

Motor benzol is a by-product from the destructive distillation of coal. From 1½ to 2 gallons of refined motor benzol is obtained per ton of coal carbonized.

It is estimated that 6,202,235,000 gallons of gasoline was produced during the year 1922. The crude light oil output during the same year is estimated at 111,000,000 gallons, or 1.8 per cent of the gasoline production. If all the coal mined were coked in by-product ovens, and the light oil recovered therefrom, this product would amount to only 15 to 20 per cent of the quantity of the petroleum gasoline now produced annually. It is obvious therefore, that the light oils by present coking processes cannot assume great importance as a gasoline substitute in a national sense. However, the use of light oil as a motor fuel is of real importance in districts adjacent to by-product coking operations from which a reasonable proportion of the local motor fuel supply may be derived. The certainty of diminution of petroleum resources in the relatively near future demands the utmost utilization of gasoline substitutes from the distillation of coal as well as other sources.

The Bureau of Mines considers that the engine tests made on motor benzol warrant constrictive discussion regarding the present specifications which manufacturers of motor-benzol fuels endeavor to meet. Greater emphasis should be placed on the amount of evaporation residue, rather than on certain other present day specifications such as color. It appears also that the initial boiling point might be lowered slightly below 78 deg. C. Results of these tests are given in Serial 2517, by A. C. Fieldner, superintendent, Pittsburgh station, and G. W. Jones, assistant gas chemist, which may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

Pressure Blower Equipment for New Gas Plant

Changes and improvements made in gas plants are becoming ever more frequent. There are but few issues of a gas journal that do not mention one or more improvements in gas equipment, construction and design.

It is difficult to speak of the modern gas plant in a collective sense. Standardization here, in equipment and design, is a comparatively unknown factor, and it is for this reason that each plant offers in itself possibility for improvement. Because of the importance of the pressure blowing system in the average gas plant, it is of interest to note the equipment to be employed at the new Iroquois Gas Corporation's plant at Mineral Spring Road, just outside the city limits of Buffalo, N. Y. The main plant of this installation, which will be for the manufacture of coal gas, will probably not be completed before September or October, 1924.

The auxiliary plant, however, will be used in the manufacture of blue water gas and is expected to be ready for operation by next January. While this auxiliary plant is not notable for its physical size or contemplated capacity production, it has points of interest, however, in that it will represent the last word in modern equipment and will have embodied the most improved methods for the manufacture of artificial gas. This auxiliary plant, manufacturing blue water gas exclusively, will have an estimated capacity through use of its three generating sets, of nine million cubic feet of gas per day. The gas will be combined with a predetermined amount of natural gas to obtain the required Btu. for heating purposes.

The pressure blowing system being installed will consist of three 85-in. special steel plate pressure blowers (manufactured by the Buffalo Forge Company of Buffalo, N. Y.) handling 26,000 cu. ft. of air per minute at a speed of 1,870 rpm. against a pressure of 36 in. static and requiring 211 hp. These blowers, incidentally, are designed and built to handle the same amount of air at 2,000 rpm. against a pressure of 42 in. static. The discharge will be of right hand angular up discharge placed at an angle of 45 deg. Construction of these blowers is of standard ¼-in. steel plate throughout. They are equipped with gusset plate side braces and blast wheels of the center

plate type with forged steel hub. The bearings are of the spherical ball and socket type mounted on cast iron pedestals. The blowers will be connected by means of Buffalo flexible couplings to Moore 1-3-R single stage steam turbines. The turbines will operate at about 120 lbs. pressure per sq. in. A cast iron bed plate will extend under both fan and turbine, the bearing pedestals being mounted on this bed plate.

Leahy No-Blind Screen Has Many Features and Uses

The Leahy No-Blind Screen has been worked out in practice as the result of a necessity for a practical vibrating screen to accomplish certain difficult screening. The new principles of screening involved in this screen are responsible for its remarkable efficiency demonstrated in two years' operation on various materials; and its simplicity, economy of operation and reasonable first cost make this mechanical vibrating screen practical for most screening operations.

Features: A quick return differential vibration is transmitted to the entire surface of the screen cloth. Particles of material are screened and stratified according to their relative masses and the finer particles are screened freely without hindrance by the oversize particles. Anvil action at the end of each quick return stroke clears the meshes of the screen cloth and the screen is non-blinding under all conditions of feed. Vibrator is mechanical, running in oil, and has only two wearing parts. Screen is operated by a 3-inch belt and requires only from one-fourth to one-half horsepower. One spring adjustment controls intensity of the vibration and adjusts vibration to suit load and material being screened. (Speed of vibration depends on drive belt speed.) Screen cloth held in longitudinal tension by two bolts and can be changed in five minutes time. It is unnecessary to purchase special screen cloth for the No-Blind Screen, as any wire mesh screen cloth 5 ft. by 36 in. wide may be used.

Uses: The screen is suitable for screening either wet or dry materials from 2-in. opening to minus 80 mesh—

Minerals	Clay
Coal	Sand and gravel
Coke	Crushed stone
Ceramic materials	Crushed slag, etc.

This screen is said to have a greater capacity than any other type of shaking or vibrating screen of equal screening area.

NEWS OF THE PLANTS

The Maryland Steel Rolling Company, Trenton, N. J., has commenced work on an improvement program at its local plant on Ingraham Avenue, for extensive increase in capacity, particularly in the line of cold rolled steel products. The installation will consist of new annealing furnaces, automatic power reels and variable speed motor-driven mills. A new type of box strap annealing furnaces will be placed in service, replacing the lead annealing furnaces heretofore used. It is expected to complete the work at the earliest possible date and place the new equipment in commission.

The American Steel & Wire Company, South La Salle Street, Chicago, Ill., a subsidiary of the United States Steel Corporation, has tentative plans under way for the construction of a series of new mills on site recently acquired at Gary, Ind., adjoining the works of the parent organization. A tract of more than 120 acres of land is available, a large portion of which will be used for the initial works. It is expected to commence active work early in the coming year.

The Inland Steel Company, Chicago, Ill., is perfecting arrangements for the purchase of the plants and properties of the Acme Steel Goods Company, of the same city, and the Milwaukee Rolling Mill Company, Milwaukee, Wis. The new owner purposes to expand the present works to greater capacity for the development of its business in different channels, and will arrange plans as soon as the properties are taken over. The Acme Company has been operating plants at Chicago and Riverdale, Ill., specializing in the manufacture of hot rolled hoop steel, barrel hoops, light cold rolled strip steel and kindred products; the company is now completing the erection of a plant for cold rolled strip material at Riverdale, said to represent an investment of close to \$1,000,000, and which is expected to be ready for service in November. The property of the Milwaukee company consists of eight sheet mills and auxiliary structures, with rated annual production of 85,000 tons of black and galvanized sheets. The Inland company, it is said, will maintain this latter works at the present location, and operate at maximum. The purchasing company has three modern blast furnaces, 22 open hearth furnaces, sheet bar mill, blooming mill, sheet mills, plate and structural mills, rail mills, bolt and spike mills and other auxiliary mill structures. It has a 50 per cent interest in the Orwell Iron

Company. The purchase price of the two new acquisitions has not been announced.

The Republic Iron & Steel Company, Youngstown, Ohio, has preliminary plans for the rebuilding of one of the structures at its local mills, recently destroyed by fire with loss approximating \$40,000. The new building is estimated to cost a like amount.

The Texas Steel Mills, Fort Worth, Texas, are perfecting plans for the proposed additions in their local plant to include a blast furnace, located in the vicinity of South Hemphill Street, and complete steel mill in neighboring district. The new structures are estimated to cost in excess of \$400,000, including machinery and operating equipment. J. F. Foster is superintendent of construction.

The Cleveland Steel Tube Company, Cleveland, Ohio, recently organized with a capital of \$1,200,000, is arranging for a bond issue of about \$500,000, a portion of the proceeds to be used for proposed expansion and additions in working capital. The new company will succeed to the plant and business of the International Steel Tube Company, bankrupt, and has purchased a tract of property adjoining the works for further additions. It is purposed to commence operations at an early date, following necessary repairs and improvements. Jacob Kahler is president of the new organization; M. E. Cunningham, secretary, and H. D. Marble, treasurer.

The Valley Rolling Mills, Inc., Elmira, N. Y., recently organized with a capital of \$750,000, has acquired a local mill and plans to inaugurate operations at an early date. The plant was constructed a number of years ago and designed for the production of merchant bars and light structural shapes. The new owner will continue in this same line and expects to commence on an output of small bars and bands, later to develop heavier material, maintaining light stocks as a feature. The company is headed by J. S. and E. F. Quirke and M. K. Sessler. The last noted will be vice president and treasurer of the organization, and in active charge of affairs.

The National Steel Products Company, 2270 Franklin Street, Detroit, Mich., has acquired property at Holly, Mich., formerly occupied by a company known as the Ground Hog Tractor Company, and will remodel and improve the works for early occupancy. Additional machinery will be installed for the production of a

line of steel products for automotive and other service.

The American Sintering Company, Youngstown, Ohio, has perfected plans for extensions and improvements in its plant at Hubbard, Ohio, designed to double approximately the present works capacity. The expansion is estimated to cost close to \$200,000, including equipment. The work will be pushed to completion and the additional units placed in service at the earliest date.

The LaFollette Coal & Iron Company, LaFollette, Tenn., operating a local blast furnace, has preliminary plans under advisement for the construction of a new by-product coke plant at its works, to be of large capacity and thoroughly modern in all particulars. The company has commenced an improvement program at the local works, comprising the installation of considerable new equipment, as well as ore storage bins, conveying equipment and kindred apparatus. It is expected to advance production as soon as the work has been completed.

The Carnegie Steel Company, Pittsburgh, Pa., is arranging plans for the construction of a new coke-handling plant at its Mingo Junction, Ohio, works, to be used in connection with the by-products coke plant of the company at Clairton, Pa., shipping the output from the last noted works to the Mingo furnaces by means of river route. The installation for the new coke-handling works will include traveling cranes, conveying machinery and auxiliary equipment, estimated to cost in excess of \$400,000. The company is maintaining operations at close to normal at its various plants in the Youngstown, Ohio, district.

The W. F. Robertson Steel & Iron Company, Cincinnati, Ohio, is making a number of improvements at the plant of the Hudson Sheet & Tin Plate Company, Marietta, Ohio, and will place the property in condition to develop maximum production as soon as operations are commenced. Arrangements are now being perfected, it is stated, to dispose of the plant output to a new local industry, for which plans will soon be consummated. The Hudson mill will be operated as a unit of the Robertson company, of which W. F. Robertson is head.

The Newton Steel Company, Newton Falls, Ohio, is arranging for the early operation of its three new sheet mills, recently completed, making a total of 20 such mills at the works. E. F. Clarke is president.

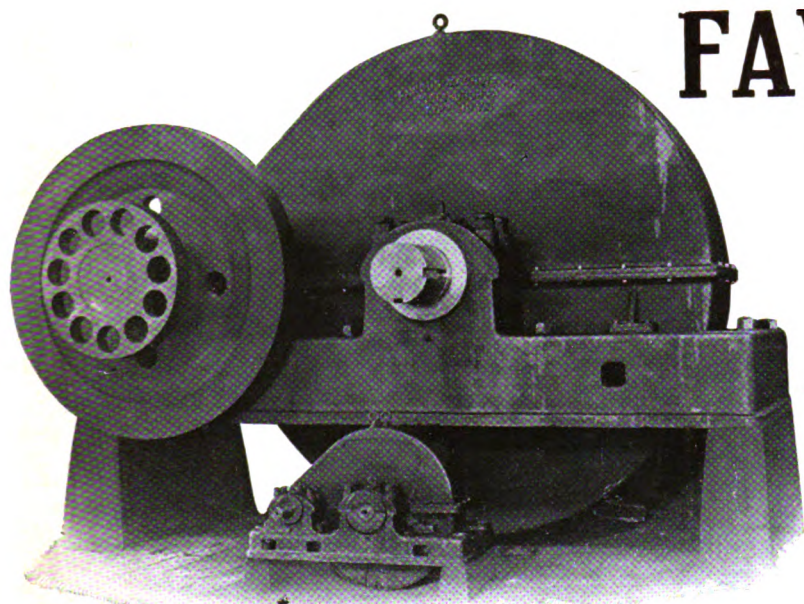
NOV 10 1923
Most Modern Sheet Mill--in December

The Blast Furnace *(and)* Steel Plant

Member of the Audit
Bureau of Circulations

PITTSBURGH, PA., NOVEMBER, 1923

Entered as second class mail matter at Pittsburgh,
Pa., under the Act of Congress, March 3, 1879.



FAWCUS HERRINGBONE GEAR DRIVES

We design and build enclosed Herringbone Gear Drives for transmitting maximum loads up to and including 15,000 horsepower for mills of all kinds.

We are well equipped both in engineering ability and manufacturing facilities to handle the unusual as well as the standard mill drive propositions.

Fawcus Drives will effect a LARGE SAVING in power consumption, wear, tear, and maintenance costs.

FAWCUS

Rolling Mills and Mill Equipment—Special Machinery—Flexible Couplings—Herringbone Gears—Spur, Bevel, Worm Gears

*Send Your Inquiries for Recommendations
and Quotations*

FAWCUS MACHINE CO.

Pittsburgh, Pa.

Representatives:

Boston, Mass.—Catlin-Calder Company.
Birmingham, Ala.—G. R. Mueller Company.
Chicago, Ill.—Hodgart & Company.
Milwaukee, Wis.—L. E. Meidinger.
New York, N. Y.—Robert C. Brown, 84 Pine Street.
Portland, Ore.—Coast Steel Machinery Company
San Francisco, Calif.—K. W. Eichelberger.

